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한국우주과학회보

Bullentin of The Korean Space Science Society

Vol.35, No.1 April 2026



사단법인 한국우주과학회
The Korean Space Science Society

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

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학회보 다운로드

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 보내 주시거나 홈페이지에서 가입하시고 입회비와 연회비는 학회 은행계좌로 송금하시기 바랍니다.

▣ 보낼곳: 한국우주과학회
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예 금 주 한국우주과학회

▣ 회비납부안내

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

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

※ 뒷면의 입회원서를 복사하여 사용해 주십시오.

[표지사진 설명]

우주물체 추락충돌 등 증가하는 우주위험으로부터 국민 안전과 국가 우주자산 보호를 위해 국가 중심의 통합적 우주안보 체계 구축과 우주교통관리 능력 확보를 목표로 하는 국가 우주상황인식시스템(K-SSA) 개발 사업('26~'30).

입 회 원 서

<table>
<tr><td rowspan="2">성 명</td><td colspan="2">한글</td><td rowspan="2">성 별</td><td>남/여</td><td>생 년 월 일</td><td colspan="2">년 월 일</td></tr>
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<tr><td>분과회 선택 (중복선택 가능)</td><td colspan="7">☐ 태양우주환경분과 ☐ 우주탐사분과 ☐ 우주관측기기분과
☐ 우주감시분과 ☐ 초소형위성분과 ☐ 우주교육유산분과
☐ 활동 안함</td></tr>
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</table>

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

년 월 일

신청인: (인)

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

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

사단법인 한국우주과학회 귀중

한국우주과학회
2026년 봄 학술대회

일　　시 : 2026. 4. 22.(수) ~ 4. 24.(금)

장　　소 : 소노캄 여수

포스터 집중 발표 : 2026. 4. 23.(목) 16:10 ~ 17:50

후　　원 : 여수시 YEOSU CITY　전라남도 문화관광재단

대한민국육군 Republic of Korea Army

등록 및 안내

1. 등록

회원의 등록비는 일반 정회원은 270,000원, 대학원생 정회원은 200,000원, 학생부과 군경은 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 시상을 합니다(세션별 좌장이 심사하지 않음).

포스터발표: 포스터 발표는 A0 사이즈 1장(A0 사이즈 1장 내에 들어갈 분량, 예를 들면 A3 8장) 크기이며 4월 22일(수) 15시까지 지정된 장소에 게시하고, 24일(금) 11시까지 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

그랜드볼룸 I	릴리 I	사파이어 I
- Invited Talk I, II - 우주물리 I, II, - 우주천문 - 우주과학 탐사선 - 태양및우주환경 I, II, III, IV	- Numerical Models of Heliospheric Space Environment - 행성탐사 대기진입 임무개발 - 행성과학 I, II, - 우주생명과학 - 대한민국 우주과학탐사 계획과 사업 추진 현황 - 화성탐사 과학미션 - K-RadCube(Artemis II CubeSat)	- 우주임무 및 시스템 - 우주산업 · 인프라 - 우주응용 · 활용 - 우주광통신 - 우주교육 문화유산

릴리 II	그랜드볼룸 II	로비	사파이어 III
- 안보우주 I, II, III - 우주정책 · 거버넌스 - 우주감시 - 커리어 콘서트	- 포스터 발표	- 전시부스	- 아이돌봄

4. 교통 안내

가. 주소: 전라남도 여수시 오동도로 111 소노캄 여수

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 소노캄
- 버스: 오동도 방면 정류장에서 2번 버스 탑승 → 오동도 입구 정류장 하차(약 10분 소요)
- 택시: 약 5,000원
- 도보: 2.1km 30분 소요

5. 구두발표 색인표

I - 1 - 1

세션번호 발표장 발표순서

2026 KSSS SPRING CONFERENCE PROGRAM

4. 22. (수)

Time	Functions
11:00~	**Registration: Lobby**
13:00~13:20	**Opening Ceremony: 그랜드볼룸 I** **개회사: 진 호 회장** **축사: 박장현 한국천문연구원 원장**
13:20~13:50	**Invited Talk I** **Room: 그랜드볼룸 I** **Chair: 곽영실(천문연)** 전인수(서울대) Navigating the Invisible Frontier: The Science of Radiation in Space Exploration
13:50~14:00	휴식(Breaktime)

Room	그랜드볼룸 I		릴리 I		사파이어 I		릴리 II	
Session I	**우주물리 I** 좌장: 나고운(경희대)		**Numerical Models of Heliospheric Space Environment** 좌장: 김수진(천문연)				**안보우주 I** 좌장: 최호성(육군)	
14:00~14:15	I-1-1	이무현	I-2-1	서정준			I-4-1	최호성
14:15~14:30	I-1-2	김고운	I-2-2	안준모			I-4-2	노유정
14:30~14:45	I-1-3	윤영수	I-2-3	이시백			I-4-3	성기평
14:45~15:00	I-1-4	박정민	I-2-4	손동희			I-4-4	유태준
15:00~15:15	I-1-5	황용석	I-2-5	김선정			I-4-5	전창수
15:15~15:30			I-2-6	민경국			I-4-6	박준
15:30~15:40	휴식(Breaktime)							
Session II	**우주과학 탐사선** 좌장: 이은상(경희대)		**행성탐사 대기진입 임무개발** 좌장: 최기혁(항우연)		**우주임무 및 시스템** 좌장: 문봉곤(천문연)		**안보우주 II** 좌장: 김동환(육군)	
15:40~15:55	II-1-1	박재홍	II-2-1	김정헌(13')	II-3-1	송재훈	II-4-1	윤정훈
15:55~16:10	II-1-2	방효충	II-2-2	김성원(13')	II-3-2	이준석	II-4-2	황준식
16:10~16:25	II-1-3	조경석	II-2-3	최기혁(13')	II-3-3	문상만	II-4-3	권오창
16:25~16:40	II-1-4	박경선	II-2-4	박재익(13')	II-3-4	우종명	II-4-4	배재호
16:40~16:55	II-1-5	박재흥	II-2-5	김재인(13')	II-3-5	이진아	II-4-5	김동환
16:55~17:10	II-1-6	김수진	II-2-6	김대영(13')	II-3-6	김동규	II-4-6	김주영
17:10~17:25	II-1-7	유광선	II-2-7	여훈정(13')	II-3-7	최현정		
17:25~17:40	토론(17:25~17:45)		II-2-8	배정주(13')	II-3-8	이준호		
			II-2-9	남유주(13')				

4. 23. (목)

Time	Functions							
Room	그랜드볼룸 I		릴리 I		사파이어 I		릴리 II	
Session III	우주물리 II / 우주천문 좌장: 박재흥(천문연)		행성과학 I 좌장: 이준현(천문연)		우주산업 · 인프라/ 우주응용 · 활용 좌장: 박원기(천문연)		안보우주 III 좌장: 박병찬(육군)	
09:00~09:15	III-1-1	박경선	III-2-1	조우인	III-3-1	유중현	III-4-1	최병규
09:15~09:30	III-1-2	오대현	III-2-2	김관혁	III-3-2	여정인	III-4-2	이우석
09:30~09:45	III-1-3	Masaru Kogure	III-2-3	박현후	III-3-3	김현성	III-4-3	김강우
09:45~10:00	III-1-4	이상현	III-2-4	이재희	III-3-4	문준서	III-4-4	김선웅
10:00~10:15			III-2-5	홍예원	III-3-5	김민기	III-4-5	김헌수
10:15~10:30			III-2-6	조은진			III-4-6	이재환
10:30~10:40	휴식(Breaktime)							
Session IV	태양 및 우주환경 I 좌장: 나고운(경희대)		행성과학 II / 우주생명과학 좌장: 이민경(천문연)				다양성위원회	
10:40~10:55	IV-1-1	이우경	IV-2-1	최변각			2026년 한국우주과학회-KIRD 학회 연계 커리어 콘서트 (12:00~) 중식 제공	
10:55~11:10			IV-2-2	김은혁				
11:10~11:25	IV-1-2	김영재	IV-2-3	김선훈				
11:25~11:40	IV-1-3	전웅	IV-2-4	정안영민				
11:40~11:55	IV-1-4	김지우	IV-2-5	이영훈				
11:55~12:10	IV-1-5	Nguyen Ngoc Huy Hoang	IV-2-6	김병호				
12:10~13:20	점심(Lunch)							
13:20~13:50	**Invited Talk II**		**Room: 그랜드볼룸 I**		**Chair: 최기혁(항우연)**			
	이영욱(연세대) Towards a New Paradigm in Supernova Cosmology							
13:50~14:00	휴식(Breaktime)							
Session V	태양 및 우주환경 II 좌장: 이종길(충북대)		대한민국 우주과학탐사 계획과 사업 추진 현황 좌장: 김민재(우주청)		우주광통신 좌장: 임형철(천문연)		우주정책 · 거버넌스 / 우주감시 좌장: 성재동(항우연)	
14:00~14:15	V-1-1	권윤영	V-2-1	박재홍	V-3-1	임권섭	V-4-1	이병선
14:15~14:30			V-2-2	김학섭	V-3-2	성기평	V-4-2	정서영
14:30~14:45	V-1-2	김보경	V-2-3	김재범	V-3-3	권영관	V-4-3	이철원
14:45~15:00	V-1-3	함영배	V-2-4	강종균	V-3-4	문우현	V-4-4	김재우
15:00~15:15	V-1-4	김정헌	V-2-5	이수형	V-3-5	여찬일	V-4-5	성재동
15:15~15:30	V-1-5	박창언	V-2-6	박진혜	V-3-6	최정원	V-4-6	김명묵
15:30~15:45	V-1-6	이재진	V-2-7	박승수	V-3-7	박상원	V-4-7	최승환
15:45~16:00	V-1-7	박성홍	V-2-8	김민성	V-3-8	이슬이	V-4-8	정유연
16:00~16:10	휴식(Breaktime)							
16:10~17:50	**포스터 세션(Poster Session): 집중 발표**							
18:00~20:30	**만찬: 그랜드볼룸 I**							

4. 24. (금)

Time	Functions							
Room	그랜드볼룸 I		릴리 I		사파이어 I		릴리 II	
Session VI	태양 및 우주환경 III 좌장: 이창섭(극지연)		화성탐사 과학미션 좌장: 한정열(천문연)		우주교육 문화유산 좌장: 조영인(천문연)			
9:00~9:15	VI-1-1	길효섭	VI-2-1	최광호	VI-3-1	김신명		
9:15~9:30	VI-1-2	정종일	VI-2-2	최기혁	VI-3-2	박지원		
9:30~9:45	VI-1-3	Sumiaya Rahman	VI-2-3	정민섭	VI-3-3	장정재		
9:45~10:00	VI-1-4	김대일	VI-2-4	한정열	VI-3-4	김상혁		
10:00~10:15	VI-1-5	손지현	VI-2-5	이우경	VI-3-5	민병희		
10:15~10:25	휴식(Breaktime)							
Session VII	태양 및 우주환경 IV 좌장: 이시백(경희대)		K-RadCube (Artemis II CubeSat) 좌장: 이덕행(천문연)		우주교육유산			
10:25~10:40	VII-1-1	이지희	VII-2-1	심채경	우주교육유산 분과총회			
10:40~10:55	VII-1-2	안승우	VII-2-2	이성환				
10:55~11:10	VII-1-3	전민규	VII-2-3	신재혁				
11:10~11:25	VII-1-4	이창섭	VII-2-4	송동욱				
11:25~11:40	VII-1-5	신승헌	VII-2-5	남욱원				
11:40~11:55	VII-1-6	김록순	VII-2-6	한진우				
11:55~12:10	VII-1-7	문용재	VII-2-7	최신규				
12:10~12:30	Closing Ceremony: 그랜드볼룸 I 우수 구두발표상, 우수 포스터상 시상식							

Poster Session

4. 23. (목) 16:10~17:50

Area	No	Author	Affiliation	Area	No	Author	Affiliation
행성 과학	P-1	이은지	천문연	우주 산업 · 인프라	P-33	백선기	항우연
	P-2	안예선	경희대		P-34	임종민	항우연
	P-3	이민경	천문연		P-35	홍승모	항우연
	P-4	김민재	경희대		P-36	박진	항우연
	P-5	권홍주	충남대		P-37	서희준	항우연
	P-6	김상화	경희대	우주 시스템 체계	P-38	백명진	항우연
태양 및 우주환경	P-7	김지은	극지연		P-39	박선엽	(주)아이옵스
	P-8	김은솔	극지연		P-40	이서림	항우연
	P-9	이은비	울산대		P-41	조승원	항우연
	P-10	장서희	천문연		P-42	방수완	항우연
	P-11	홍채정	충남대		P-43	강철	항우연
	P-12	강민욱	충남대		P-44	임원규	항우연
	P-13	이재욱	천문연		P-45	정채린	경희대
	P-14	김경수	연세대		P-46	신철수	항우연
	P-15	정세헌	천문연		P-47	김진혁	항우연
	P-16	이승현	천문연		P-48	서성원	항우연
	P-17	이종훈	(주)에스이티시스템		P-49	김화영	항우연
	P-18	조유진	극지연		P-50	김연규	항우연
	P-19	김민영	극지연		P-51	이종원	항우연
	P-20	김현남	경희대		P-52	민승용	항우연
	P-21	최두영	충북대		P-53	권경진	항우연
	P-22	주원철	경희대		P-54	김태윤	항우연
	P-23	전세린	UST		P-55	양지모	항우연
우주 응용 · 활용	P-24	서행자	항우연	우주 물리	P-56	오규민	항우연
	P-25	황나영	경희대		P-57	정종일	천문연
	P-26	이주희	항우연		P-58	이호진	천문연
우주 광통신	P-27	신재성	숭실대		P-59	박경선	충북대
우주 천문	P-28	이영석	UST	화성탐사 과학미션	P-60	민병희	천문연
우주 산업 · 인프라	P-29	박성욱	항우연	우주탐사임무	P-61	김주현	항우연
	P-30	전종협	항우연		P-62	조민지	경희대
	P-31	최지훈	항우연		P-63	김희경	항우연
	P-32	김근식	항우연		P-64	손승희	항우연

Poster Session

4. 23. (목) 16:10~17:50

Area	No	Author	Affiliation	Area	No	Author	Affiliation
우주지상국, 운용	P-65	최람미	항우연	우주시스템 부분체, 탑재체	P-79	황기룡	항우연
	P-66	김준호	기상청		P-80	정대준	항우연
	P-67	박균상	항우연		P-81	김의근	항우연
	P-68	현정훈	항우연		P-82	채동석	항우연
	P-69	안상일	항우연		P-83	송호섭	천문연
	P-70	양형모	항우연		P-84	임현구	항우연
	P-71	송창윤	항우연		P-85	박성우	항우연
	P-72	박재형	항우연		P-86	신현진	항우연
	P-73	이겨울	항우연		P-87	육영춘	항우연
우주안보	P-74	박응식	항우연		P-88	조영준	항우연
우주시스템 부분체, 탑재체	P-75	천이진	항우연		P-89	최종국	항우연
	P-76	박종억	항우연		P-90	이연경	과기원
	P-77	이종태	항우연		P-91	이한준	항우연
	P-78	연정흠	항우연				

2026년 한국우주과학회-KIRD 학회 연계 커리어 콘서트

한국우주과학회 다양성위원회는 2026년 봄학술대회 기간 동안 KIRD와 연계하여 커리어 콘서트 형식의 특별세션을 개최합니다. 본 프로그램은 산 · 학 · 연 선배 연구자들과의 만남을 통해 다양한 경력경로를 탐색하고 진로 고민을 나누는 네트워킹 프로그램입니다. 회원 여러분께서는 편안한 분위기에서 선배 연구자들과 대화를 나누며 진로 및 경력개발에 대한 유익한 정보를 얻으실 수 있습니다. 회원 여러분의 많은 관심과 참여를 바랍니다.

■ **세션개요**

- **구성:** 산업계 · 학계 · 연구계에 재직 중인 선배 연구자의 경력경로 소개 후, 토크 콘서트 형식의 질의응답 진행
- **일시 및 장소:** '26. 4. 23(목) 12:00~13:30, 여수 소노캄 릴리 II
  (중식제공, 중식 시간 운영 상황에 따라 일부 변동 가능)
- **참석대상:** 취업 및 경력개발에 관심 있는 학회 회원

■ **세션 일정**

일정	내용	담당자
12:00~12:05	**개회 및 세션 소개** **환영사**	다양성위원회 회장단
12:05~13:00	**[토크콘서트 1] 선배와의 대화** ○ 산학연 경력 경로별 사례, 주요 연구성과 소개 ○ 강연자: 산업계 · 학계 · 연구계 재직 회원 - 윤세영 PM(쎄트렉아이) - 이나영 수석연구원(LIG 넥스원) - 이진성 교수(경희대학교) - 이성환 기술이사(NARA SPACE)	강연자 4명
13:00~13:30	**[토크콘서트 2] 선배와의 대화: 소규모 그룹 토크(질의응답)** ○ 근무 만족도, 채용 성공 경험 등 공유 ○ 전공 및 취업 희망 진로 분야 기반 조별 테이블 토크로 진행	전체 참석자

구두발표 논문 제목 및 시간표

4월 22일(수)

그랜드볼룸 I

13:20 [IS-1]

Navigating the Invisible Frontier: The Science of Radiation in Space Exploration

Insoo Jun

Seoul University

그랜드볼룸 I

14:00 [I-1-1]

Measurement of the Underground Muon Flux at Y2L and Yemilab with the COSINE-100 and COSINE-100U Experiments

Moo Hyun Lee[1,2], Luis E. F. Franca[3] for COSINE-100 collaboration

[1]*Institute for Basic Science (IBS)*
[2]*University of Science and Technology (UST)*
[3]*University of Sao Paulo, Brazil*

14:15 [I-1-2]

Muon Flux at Yemilab for AMoRE-II

Go Woon Kim
(on behalf of the AMoRE Collaboration)

Center for Underground Physics, Institute for Basic Science

14:30 [I-1-3]

Measurement of Cosmic-Ray-Induced Neutron Spectra at Ground Level Using a High-Sensitivity ^{3}He Neutron Spectrometer

Young Soo Yoon, Joong Hyun Kim, Jungho Kim, Hyeonseo Park, Sinchul Kang

Korea Research Institute of Standards and Science

14:45 [I-1-4]

Enhancement of Radiation-Hardened Semiconductor Evaluation Infrastructure and Testing Facilities Using High-Energy Cosmic-Ray Analysis Techniques

Jeong Min Park, Chang Goo Kang, Yongsu Lee

Korea Atomic Energy Institute, Advanced Radiation Technology Institute

15:00 [I-1-5]

Introduction of the Space Radiation Test Facility at the KOMAC for Cosmic Ray Detection Systems

Young Seok Hwang, Myung-Hwan Jung, Yu-mi Kim, Jun Mok Ha

Korea Atomic Energy Research Institute (KAERI)

릴리 I

14:00 [I-2-1]

Conceptual Study on the Development of a Numerical Model for the Heliospheric Space Environment

Jungjoon Seough[1], Sungjung Kim[2], Junmo An[2], Sibaek Yi[2], Ryun-Young Kwon[1], Jinho Kim[1], Sujin Kim[1], Young-Sil Kwak[1], Yong-Jae Moon[2], Dongsu Ryu[3]

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

14:15 [I-2-2]

Development Strategy for a Korean Heliospheric MHD Model: Numerical Methods Survey and AI-Based Enhancement Approaches

Junmo An[1], Jungjoon Seough[2]

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

14:30 [I-2-3]

Current Status of Solar Corona Modeling and Strategies for Developing a Data-Driven Coronal MHD Code

Sibaek Yi[1], Jungjoon Seough[2]

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

14:45 [I-2-4]

PHAROS: Development of a Radiation-MHD Code for Multi-Layer Simulations of the Solar Atmosphere

Donghui Son[1], Tetsuya Magara[1,2]

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

15:00 [I-2-5]

Toward a GPU-Accelerated Hybrid Test-Particle and Stochastic Transport Framework for Solar Energetic Particle Modeling

Sunjung Kim[1], Jungjoon Seough[2]

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

15:15 [I-2-6]

Particle-in-Cell Simulations to Probe Wave-Particle Interactions in the Inner Magnetosphere

Kyungguk Min[1,2,3]

[1]*Department of Astronomy and Space Science, Chungnam National University*
[2]*Department of Earth, Environmental & Space Sciences, Chungnam National University*
[3]*Institute for Sciences of the Universe, Chungnam National University*

릴리 II

14:00 [I-4-1]

Operational Concepts of Mobile Ground-Based Laser Counter-Satellite System for ROK Army

Ho-Sung Choi[1], Inchan Lee[1], Yujung Roh[1,2], Kangwoo Kim[3]

[1]*Republic of Korea Army*
[2]*Korea Astronomy and Space Science Institute*
[3]*2nd Operation Command, Republic of Korea Army*

14:15 [I-4-2]

Evolution of the Space Security Environment and Trends in Anti-Satellite (ASAT) Technology Development

Yujung Roh[1,2], Hyung-Chul Lim[2], Ki-pyung Sung[2], Eojin Kim[2], Gwibong Kang[2], Ho-Sung Choi[1]

[1]*Republic of Korea Army (ROKA)*
[2]*Korea Astronomy and Space Science Institute (KASI)*

14:30 [I-4-3]

A Study on the Propagation Characteristics of High-Power Lasers and Their Effects on Satellite Optical Systems

Ki-pyung Sung

Korea Astronomy and Space Science Institute (KASI)

14:45 [I-4-4]

High-Repetition-Rate Petawatt Femtosecond Laser Platform for Laser-Induced Plasma Orbit Control of Space Objects

Tae Jun Yu[1,2], Doyoun Yu[2], Jaejin Lee[2], Dooyong Lee[1], Youngkwang Jung[1], Wooseok Choi[1], Geonhui Lee[1], Daewoong Park[1], Seungjin Hwang[1], Sungyoon Lee[1]

[1]*HIL Lab. Inc.*
[2]*Department of Advanced Divergence, Handong Global University*

15:00 [I-4-5]

Development of Fiber Lasers in APRI for Space and Defense Applications

Changsu Jun

Advanced Photonics Research Institute, GIST

15:15 [I-4-6]

Optical Coatings for High-Power Laser Mirrors and Satellite Constellation Mirrors

June Park, Haeng-Yun Jung, Young Bok Kim, Euisam Lee, Seung Heon Han

Korea Photonics Technology Institute

그랜드볼룸 I

15:40 [II-1-1]

Heliospheric Physics Probe Development Strategy

Jaehong Park

Korea AeroSpace Administration

15:55 [II-1-2]

Introduction to Korean Space Science Exploration Mission Design

Hyuchung Bang[1], Kyungwook Min[2,3], Kwangsun Ryu[2], Jinsung Lee[4], Dongheon Lee[1], Kyungsun Park[5], Jaeheung Park[6], Jaehong Park[7], Jongyeop Park[6], Seulmin Baek[6], Jaeheung Han[1,2], Daehyun Hwang[8], Woong-Rae Rho[9]

[1]*Department of Aerospace Engineering, KAIST*
[2]*Satellite Technology Research Center, KAIST*
[3]*Department of Physics, KAIST*
[4]*Department of Astronomy and Space Science, Kyunghee University*
[5]*Department of Astronomy and Space Science, Chungbook University*
[6]*Korea Astronomy and Space Science Institute*
[7]*Korea AeroSpace Administration*
[8]*Perigee Aerospace Inc.*
[9]*Korea Aerospace Research Institute*

16:10 [II-1-3]

The Korea-Led L4 Mission: Science Objectives and Payload Concepts for Heliophysics and Space Weather Forecasting

K.-S. Cho[1,2], KASI L4 Feasibility Study Team

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

16:25 [II-1-4]

Investigation of Solar Wind-Magnetosphere Interactions with a Dedicated Space Science Exploration Mission

Kyung Sun Park[1], Ensang Lee[2], Jaeheung Park[3], Jaehong Park[4], Jong Kil Lee[1], Junchan Lee[5], Kwangsun Ryu[5], Kyoungwook Min[6], Seulmin Baek[3]

[1]*Chungbuk National University*
[2]*KyungHee University*
[3]*Korea Astronomy and Space Science Institute*
[4]*Korea AeroSpace Administration*
[5]*Korea Advanced Institute of Science and Technology SaTReC*
[6]*Korea Advanced Institute of Science and Technology*

16:40 [II-1-5]

Conceptual Design of Low-Energy Electrostatic Analyzer (LEEA) and Heavy-Ion Composition Analyzer (HICA) for Future Korean Deep-Space Missions

Jaeheung Park[1,2], Seul-Min Baek[1], Woo-Hyeong Seol[1], Junhyun Lee[1], Jongdae Sohn[1], Tae-Yong Yang[1], Jungjoon Seough[1], Kwangsun Ryu[3], Kyoung Wook Min[3]

[1]*Korea Astronomy and Space Science Institute (KASI)*
[2]*University of Science and Technology (UST)*
[3]*Korea Advanced Institute of Science and Technology (KAIST)*

16:55 [II-1-6]

Middle Corona Linking from Sun to Heliosphere: Wide Field Solar EUV Imager

Sujin Kim, Jong-Yeop Park

Korea Astronomy and Space Science Institute

17:10 [II-1-7]

Conceptual Design of Korean Space Science Exploration Mission: Orbit, Payloads, and Satellite Development

Kwangsun Ryu[1], Kyungwook Min[1,2], Hyuchung Bang[3], Jinsung Lee[4], Dongheon Lee[3], Junchan Lee[1], Hanik Kim[1], Kyungsun Park[5], Jaeheung Park[6], Jaehong Park[7], Jongyeop Park[6], Seulmin Baek[6], Jaeheung Han[1,3], Daehyun Hwang[8], Woong-Rae Rho[9]

[1]*Satellite Technology Research Center, KAIST*
[2]*Department of Physics, KAIST*
[3]*Department of Aerospace Engineering, KAIST*
[4]*Department of Astronomy and Space Science, Kyunghee University*
[5]*Department of Astronomy and Space Science, Chungbook University*
[6]*Korea Astronomy and Space Science Institute*
[7]*Korea AeroSpace Administration*
[8]*Perigee Aerospace Inc.*
[9]*Korea Aerospace Research Institute*

릴리 I

15:40 [II-2-1]

Sensitivity of Martian Atmospheric Conditions to Dust and Solar EUV Activity along Mars Entry Trajectories Using the Mars Climate Database Model

Jeong-Heon Kim[1], Young-Sil Kwak[1,2], Jaewook Lee[1]

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

15:53 [II-2-2]
Light-Weight Ablative Thermal Protection Materials for Mars Entry

Seongwon Kim[1], Min-Soo Nam[1,2]

[1]*Cross-Functional Ceramics R&D Group, Korea Institute of Ceramic Engineering and Technology*
[2]*Department of Materials Science and Engineering, Korea University*

16:06 [II-2-3]
Overseas Development Status of Mars Atmosphere Entry Aeroshell and Analysis of 1D Trajectory and Aerodynamic Heating

Gi-Hyuk Choi, Dae-Young Kim, Jae-Ik Park, Jae-In Kim, Chun-Woo Lee

Korea Aerospace Research Institute

16:19 [II-2-4]
Development of an Integrated Verification Framework for Mars Atmospheric Entry-Descent-Landing

Jae-ik Park, Dae Yeong Kim, Gi-Hyuk Choi, Jae In Kim, Seung-ryeol Oh, Jung-Ju Bae, Min Ki Kim, Jeong Heum Im, Choon Woo Lee

Korea Aerospace Research Institute

16:32 [II-2-5]
A Study on Robust Localization for Terrain Relative Navigation on Mars

Jae-In Kim

Korea Aerospace Research Institute

16:45 [II-2-6]
Design Criteria and TPM Characteristics of Mars Entry Capsules

Dae Yeong Kim, Gi-Hyuk Choi, Jae-ik Park, Jae In Kim, Seung-ryeol Oh, Jung-Ju Bae

Korea Aerospace Research Institute

16:58 [II-2-7]
Development of Aerothermodynamic Characteristics and Trajectory Analysis Program for Mars Atmospheric Entry Capsule Design

Hoonjung Yeo[1], Na Kyeong Kim[1], Jae Gang Kim[2], Kyu Hong Kim[1,3]

[1]*Department of Aerospace Engineering, Seoul National University,*
[2]*Department of Aerospace System Engineering, Sejong University*
[3]*Institute of Advanced Aerospace Technology, Seoul National University*

17:11 [II-2-8]
Analysis of Mars Arrival Conditions for Solar Sail Spacecraft Considering Entry Interface Constraints

Jung-Ju Bae, Jae-ik Park, Dae Yeong Kim, Gi-Hyuk Choi, Jae In Kim, Seung-ryeol Oh, Min Ki Kim, Jeong Heum Im, Choon Woo Lee

Korea Aerospace Research Institute

17:24 [II-2-9]
Integrated Simulation Framework for Atmospheric Entry and Vehicle Motion Analysis

Yuju Nam, Sang Lee

Korea Advanced Institute of Science and Technology

사파이어 I

15:40 [II-3-1]
A Qualitative Study on the Functional Requirements for Development of Lunar Communication Relay Orbiter

Jae-Hoon Song, Sang-Man Moon, Inkyu Kim

Korea Aerospace Research Institute

15:55 [II-3-2]
Analytical Study of Self-Flipping Conditions for Two-Wheeled Rover

Junseok Lee[1], Taeyoung Lee[1,2], Namsuk Cho[1]

[1]*Unmanned Exploration Laboratory (UEL)*
[2]*Industry 4.0 Center, College of Engineering, Hanyang University*

16:10 [II-3-3]
Indoor Test Facility for Lunar Surface Localization

of a Lunar Surface Vehicle

Sangman Moon[1], Inkyu Kim[1], Jaehoon Song[1], Kyung-Soo Ha[2], Dong-Hee Kang[2], Dong-Chan Kim[2], Jong-Myung Woo[2]

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

16:25 [II-3-4]

Design of a Radio Wave Source CubeSat for the Lunar Exploration Relay Satellite

Kyung-Soo Ha[1], Moon-Gi Hong[1], Dong-Hee Kang[1], Dong-Chan Kim[1], Sangman Moon[2], Inkyu Kim[2], Jong-Myung Woo[1]

[1]*Chungnam National University (CNU)*
[2]*Korea Aerospace Research Institute (KARI)*

16:40 [II-3-5]

Preliminary Stability Analysis of Coupled Motions of an Asteroid Probe Using the Rigid-Body Potential

Jinah Lee[1], Jay McMahon[2], Daniel Scheeres[2], Chandeok Park[1]

[1]*Department of Astronomy, Yonsei University*
[2]*Department of Aerospace Engineering Sciences, University of Colorado Boulder*

16:55 [II-3-6]

Design Concepts and Key Requirements for Operation Display and Visualization Architecture of the Korea Pathfinder Lunar Lander Ground System

Dong-Gyu Kim

Korea Aerospace Research Institute

17:10 [II-3-7]

A Drone-Based Onboard AI Testbed for Space Mission

Hyun Jeong Choi, Jeong-In Yeo, Na-Yeong Hwang, Yong-Jae Moon

G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University

17:25 [II-3-8]

LEOP Results and Analysis of CAS500-3 (Compact Advanced Satellite) After Launch

Junho Lee, Juhwang Kim, Tae Seog Kim, Eui Hyun Lim, Jong-Jin Jang

Korea Aerospace Industry

릴리 II

15:40 [II-4-1]

A Study on the Response of the Army After the Fall of Space Objects Based on the Integrated Defense Concept

Jeong Hoon Yun, Oh Chang Kwon, Jaeho Bae, Deug Ki Lim, Han kyu Nam

Republic of Korea Army

15:55 [II-4-2]

An Iterative Hypothesis Verification-Based Multi-Agent Framework for Object Activity Inference in High-Resolution Satellite Imagery

Junesik Hwang, Daewon Jung, Minseok Park

University of Science and Technology (UST), KARI

16:10 [II-4-3]

The Impact of Space Weather on Military CubeSatellite Orbital Operations and Operational Response Strategies

Oh-Chang Kwon[1,2,3], JaeHwan Lee[1], Hosub Song[3], Ki Hwan Keum[3], Jaejin Lee[3], Jongdae Sohn[3], Tae-Yong Yang[3], Youngbum Song[3], Jaeheung Park[3]

[1]*Republic of Korea Army*
[2]*Korea Astronomy and Space Institute Campus, University of Science and Technology-Korea Astronomy and Space Science Institute*
[3]*Korea Astronomy and Space Science Institute*

16:25 [II-4-4]

Characteristics Analysis of SAR Jamming and Interference Cases

Jaeho Bae[1,2], Jaemin Shin[1,3]

[1]*University of Science and Technology (KARI School)*
[2]*Republic of Korea Army*
[3]*KOMPSAT-6 System Team, Korea Aerospace Research Institute (KARI)*

16:40 [II-4-5]

A Study on the Establishment of a Next-Generation Gravity Security Monitoring System Using Satellite Gravity Data: Focusing on the Achievements of the GRACE and GRACE-FO Missions

Donghwan Kim

Department of Civil Engineering, Korea Army Academy

16:55 [II-4-6]

Machine Learning Ensemble-Based Automatic Classification of GNSS Interference Signals for Navigation Warfare (NAVWAR) Countermeasures

Jooyoung Kim[1,2]

[1]*Department of Future Air Mobility, Korea Aerospace University*
[2]*12th Infantry Division, Republic of Korea Army*

4월 23일(목)

그랜드볼룸 I

09:00 [III-1-1]

Global Simulation for Ancient Mars Interaction with the Solar Wind of the Young Sun

Kyung Sun Park[1], Kanako Seki[2], Jaeheung Park[3]

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

09:15 [III-1-2]

Multi-Point Geostationary Observation of Recent Major Space Weather Events

Daehyeon Oh, Eunjeong Cha

National Meteorological Satellite Center, Korea Meteorological Administration

09:30 [III-1-3]

Intense Gravity Waves Observed by AWE over the Korean Peninsula during an Sever Winter Storm over Japan in January 2024

Masaru Kogur[1], In-Sun Song[1], Hosik Kam[2]

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

09:45 [III-1-4]

Introduction to Scientific Mission Concept for a 3.5-m Class Space Telescope

Sang Hyun Lee, Yong-Woo Kang, Jeong-Yeol Han, Bongkon Moon, Sungwook E. Hong, Donguk Song, Juhyung Kang, Chung-Uk Lee

Korea Astronomy and Space Science Institute

릴리 I

09:00 [III-2-1]

Conducting Layer in the Lunar Farside Mantle Inferred from KPLO Magnetometer

Wooin Jo[1], Ian Garrick-Bethell[2], Ho Jin[1], Shahab Fatemi[3], Andrew R. Poppe[4], Khan-Hyuk Kim[1], Hyeonhu Park[1]

[1]*Kyung Hee University*
[2]*University of California, Santa Cruz*
[3]*Umea University*
[4]*University of California, Berkeley*

09:15 [III-2-2]

Origin and Dynamics of Lunar Ions in the Magnetotail Lobes: Observations and Simulations

Khan-Hyuk Kim[1], Jaehee Lee[1], Yewon Hong[1], Dongseok Yun[1], Ho Jin[1], Seul-Min Baek[2]

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

09:30 [III-2-3]

Investigation of the Magnetization Near Descartes Magnetic Anomaly

Hyeonhu Park[1], Ian Garrick-Bethell[2], Ho Jin[1]

[1]*Kyung Hee University*
[2]*University of California, Santa Cruz*

09:45 [III-2-4]

Statistical Study of Moon-Originating Ions in the Solar Wind

Jaehee Lee[1], Khan-Hyuk Kim[1], Yewon Hong[1], Seul-Min Baek[2], Ho Jin[1], Junhyun Lee[2]

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

10:00 [III-2-5]

Interaction between Solar Wind Particles and the Reiner Gamma Magnetic Anomaly: Observations and Test-Particle Simulations

Yewon Hong[1], Khan-Hyuk Kim[1], Jaehee Lee[1], Ho Jin[1], Seul-Min Baek[2]

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

10:15 [III-2-6]

Spectral and Polarimetric Properties of Reduced Lunar Simulants with Grain Size and Metallic Iron Particles

Eunjin Cho[1], Seungju Han[2,3], Youngjae Kim[2], Serin Kim[1,3], Keewook Yi[4], Eunji Yi[1,3], Dongha Shin[5], Eunhee Kim[5], Mingyeong Lee[1], Chae Kyung Sim[1,3], Minsup Jeong[1]

[1]*Korea Astronomy and Space Science Institute (KASI)*
[2]*Korea Institute of Civil Engineering and Building Technology (KICT)*
[3]*University of Science and Technology (UST)*
[4]*Korea Basic Science Institute (KBSI)*
[5]*Inha University*

사파이어 I

09:00 [III-3-1]

Space Situational Awareness Sharing through SpaceTube

Peter JH Ryu[1,2,3], Shawn SH Choi[1,2,3], Henry H Hur[1], Franklin DI Kang[1], Alan SG Lee[1], Ethan SH Roh[1], Daniel MU Cho[1], Chase SG Hong[1], Douglas DS Kim[1,2,3]

[1]*SpaceMap Inc.*
[2]*Voronoi Diagram Research Center*
[3]*Hanyang University*

09:15 [III-3-2]

Onboard AI for Autonomous Observation Systems: Drone-Based Technology Demonstration for Event-Triggered Adaptive Sensing

Jeong-In Yeo[1], Hyun Jeong Choi[1], Na-Yeong Hwang[1], Yong-Jae Moon[1,2]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

09:30 [III-3-3]

Lunar Terrain Relative Navigation: Integration of Vision-Based Methods

Hyunsung Kim, Sunwoo Mun, Seokju Lee

Korea Institute of Energy Technology

09:45 [III-3-4]

Lunar Landing Site Evaluation: Self-Organizing Maps with Temporal Solar Visibility

Junseo Moon, Seokju Lee

Korea Institute of Energy Technology

10:00 [III-3-5]

Tests for Prototype of Dragsail Deorbiter for Active Debris Removal

Min-Ki Kim

Korea Aerospace Research Institute

릴리 II

09:00 [III-4-1]

GNSS Precise Point Positioning for the ROKN Cruise Training Ship

Byung-Kyu Choi[1], Dong-Hyo Sohn[1], Jong-Kyun Chung[1], Dong-Jin Han[2], Junseok Hong[1]

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

09:15 [III-4-2]

International Trends in Multi-Layered Orbital Navigation (LEO-PNT) and the Application of Ultra-Precise Navigation in Ground Operations

Woo-seok Lee, In-chan Lee

Republic of Korea Army HQ

09:30 [III-4-3]

The Importance of Rear Area Operations in Conducting Space Operations

Kang-woo Kim[1], Ho-Sung Choi[2], Jun-hyun Park[1]

[1]*2nd Operational Command*
[2]*Korea army Headquarter*

09:45 [III-4-4]

Quantitative Cost-Benefit Analysis of LEO Satellite Communication for Korean Army Operations: Lessons from the Ukraine War Applied to the Korean Peninsula

Seon Woong Kim

1st Battalion, 108th Brigade, 36th Infantry Division, Republic of Korea Army

10:00 [III-4-5]

Autonomous Survivability for Small-Sat Constellations: An Intelligent Diagnosis Platform Based on Time-Series Periodicity Learning

Heonsu Kim[1], Hyeokmoon Yu[1], Jinyoung Bae[1], Joonki Paik[2]

[1]*Republic of Korea Army*
[2]*Department of Visual & Intelligent Systems Lab, Graduate School of AI, Chung-Ang University*

10:15 [III-4-6]

A Review on Technical Trends of U.S. SDA's Proliferated Warfighter Space Architecture (PWSA) and Implications for the Development of ROK Military Satellite Systems

Jaewhan Lee[1], Oh-chang Kwon[1,2], Hosub Song[3], Jaejin Lee[3]

[1]*Republic of Korea Army*
[2]*Korea Astronomy and Space Institute Campus, University of Science and Technology - Korea*
[3]*Korea Astronomy and Space Institute*

그랜드볼룸 I

10:40 [IV-1-1]

Pioneering Auroral Imaging in Korea: First Results of ROKITS and the Path Forward

Woo Kyoung Lee[1,2], Hyosub Kil[1,3], Chanhaeng Lee[1], Se-Heon Jeong[1], Serin Jeon[1,2], Larry J. Paxton[3], ROKITS Team[1]

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

11:10 [IV-1-2]

Interpretable Data-Driven Models for Solar Flare Forecasting by Deep Learning and Symbolic Regression

Youngjae Kim[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[3], Gwangson Choe[1], Jihyeon Son[4], Mingyu Jeon[1]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Astronomy & Space Science,Kyung HeeUniversity*
[3]*KU Leuven, Belgium*
[4]*Korea Astronomy and Space Science Institute*

11:25 [IV-1-3]

Validation of Global Ionospheric Maps over Oceanic Regions Using Altimeter-Derived TEC

Woong Jeon[1,2], Woo Kyoung Lee[1,3], Hyosub Kil[1,4], Yong-Jae Moon[5,6]

[1]*Korea Astronomy and Space Science Institute*
[2]*School of Space Research, Kyung Hee University*
[3]*University of Science and Technology*
[4]*Johns Hopkins University Applied Physics Laboratory*
[5]*Department of Astronomy and Space Science, Kyung Hee University*
[6]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*

11:40 [IV-1-4]

Assessing High-Latitude Electrodynamic Drivers in SD WACCM-X

Jiwoo Kim[1], In-Sun Song[1], Wonseok Lee[2,3], Ja Soon Shim[2,4], Nicholas M. Pedatella[5,6]

[1]*Department of Atmospheric Sciences, Yonsei University*
[2]*NASA Goddard Space Flight Center, Greenbelt, USA*
[3]*Department of Physics, Catholic University of America, Washington, USA*
[4]*Science and Technology Institute, Universities Space Research Association, Huntsville, USA*
[5]*NSF National Center for Atmospheric Research, High Altitude Observatory, Boulder, USA*
[6]*COSMIC Program Office, University Center for Atmospheric Research, Boulder, USA*

11:55 [IV-1-5]

Evaluation of Irregularity Detection in the Bottomside Ionosphere Using COSMIC Data

Hoang Nguyen[1,2], Young-sil Kwak[1,2], Hyosub Kil[1,3]

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

릴리 I

10:40 [IV-2-1]

Science Missions, Landing Site Geology, and Payloads of Lunar Landers: Implications for the Korean Lunar Lander program

Byeon-Gak Choi

Seoul National University

10:55 [IV-2-2]

Characteristics of Spacecraft Jitters and Mitigation Plan for ShadowCam Stereo Imaging of the Korea Pathfinder Lunar Orbiter

Eunhyeuk Kim[1], Madeleine Manheim[2], Aaron Boyd[2], Moon-Jin Jeon[1], Mark Robinson[2], Prasun Mahanti[2]

[1]*Korea Aerospace Research Institute (KARI)*
[2]*Intuitive Machines (IM)*

11:10 [IV-2-3]

Hazard Characterization of Permanently Shadowed Regions on Mons Mouton from Multi-Source Orbital Data

Seon-Hoon Kim[1,2], Seonho Lee[1,2], Daewon Chung[1,2]

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

11:25 [IV-2-4]

Candidate Target Search for a Korean Asteroid Impactor Mission

Youngmin JeongAhn, Hee-Jae Lee, Myung-Jin Kim, Hong-Kyu Moon, Sunho Jin

Korea Astronomy and Space Science Institute

11:40 [IV-2-5]

Gravito-Electroporation: A Drop-Tower-Based Platform for Gene Delivery under Variable Gravity toward Astropharmacy Applications

Younghoon Lee, Vu Huu Pham, Sangmin Park, Seokbeom Lee

Space LiinTech Inc.

11:55 [IV-2-6]

Autonomous Protein Crystallization under Microgravity: In-Orbit Demonstration of the BEE-PC1 Platform on the ISS

Jinyang Chung[1], Vu Huu Pham[1], Sangchul Shin[2], Jungmin Yoon[1], Byungho Kim[1]

[1]*Space LiinTech Inc.*
[2]*KIST (Korea Institute of Science and Technology)*

그랜드볼룸 I

13:20 [IS-2]

Towards a New Paradigm in Supernova Cosmology

Young-Wook Lee

Yonsei University

그랜드볼룸 I

14:00 [V-1-1]

The 19 January 2026 S4 Level Solar Proton Event: Was It Driven by an Exceptionally Intense Solar Eruption?

Ryun Young Kwon

Korea Astronomy and Space Science Institute

14:30 [V-1-2]

Comparative Analysis of Subsurface Flows Beneath Solar Active Regions 12738 and 12673 Using Time-Distance Helioseismology

Bogyeong Kim[1], Sung-Hong Park[2], Yu Yi[1]

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

14:45 [V-1-3]

Comparison of the Old TIE-GCM 2.0 with the Latest Version Regarding High-Latitude ExB Drifts

Young-Bae Ham[1,2], Geonhwa Jee[1,2]

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

15:00 [V-1-4]

Impact of Geomagnetic Storm Intensity on Thermospheric Density Enhancement and Orbital Decay of LEO Satellites

Jeong-Heon Kim[1], Giwwong Eom[2], Young-Sil Kwak[1,3], Tae-Yong Yang[1], Hwanil Huh[2]

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

15:15 [V-1-5]

Empirical Formula of CME Travel Time by Symbolic Regression

Changeon Park, Youngjae Kim, Mingyu Jeon, Yong-Jae Moon

G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University

15:30 [V-1-6]

Butterfly Pitch Angle Distributions in LEO: Signatures of Electron Loss from the Inner Radiation Belt

Jaejin Lee, Jaehung Park, Hosub Song, Jongdae Sohn, Tae-Yong Yang

Korea Astronomy and Space Science Institute

15:45 [V-1-7]

Revisiting Flare-CME-SEP Relations

Sung-Hong Park[1,2]

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

릴리 I

14:00 [V-2-1]

Lunar Communication Orbiter Development Strategy

Jaehong Park

Korea AeroSpace Administration

14:15 [V-2-2]

Mars Exploration Base Technology Demonstration Initiative

Hak-Sub Kim, Hwasu Hyun

Korea AeroSpace Administration

14:30 [V-2-3]

Current Status of SKAO International Cooperation and Domestic Policy Trends

Jaebeom Kim

Korea AeroSpace Administration

14:45 [V-2-4]

Small-Scale Unmanned Space Manufacturing Platform Demonstration

Jong-gyun Kang, Minjae G. Kim, Suhyeong Lee, Subin Baek, Jihun Kwon

Korea AeroSpace Administration

15:00 [V-2-5]

Toward Digital Engineering in Space Science Explorations

Suhyeong Lee, Subin Baek, Minjae Kim, Jonggyun Kang, Jihun Kwon

Korea AeroSpace Administration

15:15 [V-2-6]

Lunar Surface Science and Technology Missions: Current Status and Future Plans

Jinhye Park

Lunar Lander Program, Space Science Exploration Directorate, KASA

15:30 [V-2-7]

KASA's Plan for Lunar Surface Mobility and Infrastructure

Seungsoo Park, Sunhoon Kim, Jinhye Park, Minseong Kim, Ijeung Kim, Beomseok Lee, Dong Young Rew

Korea AeroSpace Administration

15:45 [V-2-8]

Current Status and Future Perspectives: Lunar Lander Development of Republic of Korea

Minseong Kim, Sunhoon Kim, Beomseok Lee, Seungsoo Park, Jinhye Park, Ijeung Kim, Dongyoung Rew

Korea AeroSpace Administration

사파이어 I

14:00 [V-3-1]

Design of the Optical Communication Terminal for the Next-Generation LEO Satellite Constellation

Kwon-Seob Lim, Man-Seok Uhm, Dong-Pil Chang

Electronics and Telecommunications Research Institute

14:15 [V-3-2]

Design and Development of a Ground-Based Optical Communication Terminal

Ki Pyoung Sung, Hyung-Chul Lim, Sung-Yeol Yu, Sang-won Park

Korea Astronomy and Space Science Institute

14:30 [V-3-3]

High-Performance Fine Steering Mirrors for Space Optical Communication Systems

Young Kwan Kwon, Ju Hahn Lee, Won Jun Lee, Jae Young Jeong, Jung Cho, Byung Jik Lim

Incerasolution Co., Ltd

14:45 [V-3-4]

Minimum Link Distance of Terrestrial Testbed for Emulating Satellite-to-Ground Free-Space Optical Links

Woohyeon Moon, Hoon Kim

School of EE, KAIST

15:00 [V-3-5]

PAT Subsystem with Adaptive Anti-Saturation Function in Free Space Laser Communications

Chan Il Yeo, Young Soon Heo, Si Woong Park, Gang Min Bae, Hyung Jun Park

Electronics and Telecommunications Research Institute

15:15 [V-3-6]

Optical Link Loss Estimation from Measurements of Atmospheric Turbulence in 3-km FSO Experiments

Jungwon Choi[1], Wonseok Kang[1], Taewoo Kim[1], Seongjin Kim[1], Yong-sun Park[1,2], SangHoon Oh[1]

[1] *SPACEBEAM Inc.*
[2] *Department of Physics and Astronomy, Seoul National University*

15:30 [V-3-7]

Performance Analysis of Spherical Wave-Based Tip-Tilt Compensation for 20.5 km Long-Range FSOC Links

Sang-Won Park[1], Hyung-Chul Lim[1], Dae-Young Lee[2]

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

15:45 [V-3-8]

Overview of CONTEC Global Optical Ground Stations for Satellite-to-Ground Free-Space Optical Communication

Seullee Lee, Taehyun Kim, Jihye Kim, Kihwan Choi

CONTEC Co., Ltd

릴리 II

14:00 [V-4-1]

Key Discussions and Outcomes of the 2nd Joint Multilateral Cislunar PNT Workshop: Advancing Global Interoperability for Sustainable Lunar Exploration

Byoung-Sun Lee

Korea AeroSpace Administration (KASA)

14:15 [V-4-2]

Registration of Lunar Orbiters under the Current UN Framework: Issues and Considerations from the Case of KPLO

Soyoung Chung[1], Joon Lee[1], Jiwon Lee[2],

Joonwon Kang[2], Young-Joo Song[2]

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

14:30 [V-4-3]

A Comparative and Analytical Study on Space Cybersecurity Guidelines of Major Countries

Cheol Won Lee, Seyoung Baik, Deokjin Kim

The Affiliated Institute of ETRI

14:45 [V-4-4]

Updates on Space Collision Risk Analysis Framework

Jaewoo Kim[1], Minchan Song[1], Eun Jung Choi[2,3], Jin Choi[2,3], Jiwoong Yu[2], Junghyun Jo[2], Hosik Kam[2], Jaemyung Ahn[1]

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

15:00 [V-4-5]

Detection and Classification of Orbital Behavior Changes Using TLE-Based Two-Stage Analysis Pipeline

Jaedong Seong

Korea Aerospace Research Institute

15:15 [V-4-6]

PASU: Design of an Ontology- and AI-Based Space Spectrum Surveillance Platform

Myungmuk Kim, Youeyun Jung, Jaedong Seong

Korea Aerosapce Research Institute

15:30 [V-4-7]

Conjunction Risk Hotspots in the Era of One Million Satellites

Seunghwan Choi[1,2], Joonghyun Ryu[1,2], Deok-Soo Kim[1,2]

[1]*SpaceMap Inc.*
[2]*Hanyang University*

15:45 [V-4-8]

Fundamental Research on the Development and Operational Strategy of a Radar System for Space Asset Protection

Youeyun Jung, Saehan Song, Jaedong Seong, Okchul Jung

Korea Aerospace Research Institute

4월 24일(금)

그랜드볼룸 I

09:00 [VI-1-1]

Assessment of Space-Based Optical Observations for the Study of Atmospheric Gravity Waves and Ionospheric Dynamics

Hyosub Kil[1], Serin Jeon[2], Sunwoo Park[3], Woo Kyoung Lee[1,2], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology (UST)*
[3]*Chungnam National University*

09:15 [VI-1-2]

Response of LEO-DOS Neutron Spectrometer to the May 2024 Superstorm

Jongil Jung[1], Young-Sil Kwak[1,2], Uk-Won Nam[1], Suyeon Oh[3], Won-Kee Park[1], Jongdae Sohn[1], Bongkon Moon[1]

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

09:30 [VI-1-3]

Improving Spatial and Temporal Resolution of SUVI/EUV Data from SDO/AIA Using AI-Model

Sumiaya Rahman[1], Bendict Lawrance[2], Ashraf Siddique[3], Yong-Jae Moon[1,4], Suhyun Kim[5], Hyun-Jin Jeong[6]

[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*Department of AI-based Big Data Management, Gangseo University*
[3]*Graduate School of Artificial Intelligence, Ulsan National Institute of Science & Technology (UNIST)*
[4]*G-LAMP NEXUS Institute, School of Space Research, Kyung Hee University*
[5]*College of Software, School of Computer Science and Engineering, Kyung Hee University*

[6]*Center for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium*

09:45 [VI-1-4]

Denoising SDO/AIA Images for Enhanced Coronal Observations by Deep Learning

Daeil Kim[1], Yong-jae Moon[1,2], Seungheon Shin[1], Junmu Youn[1], Mingyu Jeon[1], Yeoungjae Kim[1], Seungwoo Ahn[1]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

10:00 [VI-1-5]

Forecast of SYM-H Index under Strong Southward IMF Condition by Deep Learning

Jihyeon Son[1], Yong-Jae Moon[2,3], Young-Sil Kwak[4,5], Seungheon Shin[3]

[1]*Center for Heliophysics Research, Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, Kyung Hee University*
[3]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[4]*Division of Fundamental Astronomy, Korea Astronomy and Space Science Institute*
[5]*University of Science and Technology*

릴리 I

09:00 [VI-2-1]

Mission Scenario Planning and Conceptual Design of an ENA Imager for Future Korean Mars Exploration

Kwang-Ho Choi[1], Dae-Young Lee[1], Ji-Hyeon Yoo[2], Seunguk Lee[3]

[1]*Chungbuk National University*
[2]*KASI*
[3]*KBSI*

09:15 [VI-2-2]

Planetary Subsurface Exploration Mission Development

Gi-Hyuk Choi, Dae-Young Kim

Korea Aerospace Research Institute

09:30 [VI-2-3]

Payload Architecture for High-Reliability Mars Surface Exploration: The MIRINAE and NABI Systems

Minsup Jeong[1], Chae Kyung Sim[1,2], Dukhang Lee[1,2], Bongkon Moon[1,2], Jeong-Yeol Han[1,2]

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

09:45 [VI-2-4]

Payload Engineering Concepts for Mars Rover/Lander Missions: MarsVision 3D Multispectral Polarimetric Camera and a 100 mm-Class Telescope

Jeong-Yeol Han[1,2], Chae Kyung Sim[1,2], Minsup Jeong[1,2], DukHang Lee[1,2], Bongkon Moon[1,2], Seung-Kyun Ryu[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*IMAero Co., Ltd.*

10:00 [VI-2-5]

Development of a Wide-Field Visible Camera Concept for Observing Martian Aurora and Airglow

Woo Kyoung Lee[1,2], Hyosub Kil[1,3], Jaewook Lee[1], Se-Heon Jeong[1], Serin Jeon[1,2], Chanhaeng Lee[1], Jeong-Heon Kim[1]

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

사파이어 I

09:00 [VI-3-1]

A Study on Space Education for Expanding Public Engagement in Space

Shin-Myeong Kim, Jae-Hee Seo

Korea Advanced Institute of Science and Technology

09:15 [VI-3-2]

Reconceptualizing Astronomical Observation through Measurement Constraints: A Laboratory

Integration of Interferometry and Quantum Sensing

Ji-Won Park[1,2], Yong-Gi Kim[1,2]

[1]*Chungbuk National University*
[2]*Chungbuk ProMaker Center*

09:30 [VI-3-3]

Analysis of the Gap between Altmetric Attention and Research Trends in Astronomy and Space Science

Jung-Jae Jang[1], Ji-Won Park[1,2], Yong-Gi Kim[1,2]

[1]*Chungbuk National University*
[2]*Chungbuk ProMaker Center*

09:45 [VI-3-4]

Projection Principles and Astronomical Significance of the *Ganpyeong-Ilgu* and *Hongae-Ilgu*

Sang Hyuk Kim[1], Byeong-Hee Mihn[1,2,3], Ki-Won Lee[4]

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

10:00 [VI-3-5]

Chinese Knowledge on Mechanical Clocks in the Early 19th Century

Byeong-Hee Mihn[1,2,3], Sang Hyuk Kim[1], Kyoung-Uk Nam[4], Hong Soon Choi[1,2], Ki-won Lee[5]

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

그랜드볼룸 I

10:25 [VII-1-1]

Responses of the Middle Atmosphere by Strong Geomagnetic Storms in 2024

Ji-Hee Lee[1], Geonhwa Jee[1,2]

[1]*Korea Polar Research Institute*
[2]*Department of Polar Science, Korea University of Science and Technology*

10:40 [VII-1-2]

A Data-Driven Empirical Formula for Solar Wind Speed Prediction by Symbolic Regression

Seungwoo Ahn[1,2], Youngjae Kim[1,2], Mingyu Jeon[1,2], Hyun-Jin Jeong[1,3], Daeil Kim[1,2], Junmu Youn[1,2], Yong-Jae Moon[1,2,4]

[1]*School of Space Research, Kyung Hee University*
[2]*G-LAMP NEXUS Institute, Kyung Hee University*
[3]*Centre for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium*
[4]*Department of Astronomy and Space Science, Kyung Hee University*

10:55 [VII-1-3]

Real-Time Extrapolation of Solar Force-Free Fields Using a Physics-Informed Neural Operator

Mingyu Jeon[1,2], Hyun-Jin Jeong[1,3] Yong-Jae Moon[1,2,4], Jihye Kang[2,4], Kanya Kusano[5]

[1]*School of Space Research, Kyung Hee University*
[2]*G-LAMP NEXUS Institute, Kyung Hee University*
[3]*Centre for Mathematical Plasma Astrophysics, KU Leuven, Belgium*
[4]*Department of Astronomy and Space Science, Kyung Hee University*
[5]*Institute for Space-Earth Environmental Research, Nagoya University, Japan*

11:10 [VII-1-4]

Upper Atmospheric Responses to G4+ Geomagnetic Storms Across the Solar Activity Cycle

Changsup Lee[1,2], Geonhwa Jee[1,2], Jeong-Han Kim[1], Jieun Kim[1]

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

11:25 [VII-1-5]

SWA-GPT: Space Weather Assistant with Multi-Agent System

Seungheon Shin[1], Yong-Jae Moon[1,2], Jihyeon Son[3]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department Astronomy and Space Science, Kyung Hee University*
[3]*Center for Heliophysics Research, Korea Astronomy and Space Science Institute*

11:40 [VII-1-6]

Sun-Earth Connection in the Last Millennium Using Korean Historical Sunspot and Red Aurora Records

Rok-soon Kim[1], Hong-Jin Yang[1,2], Kyung-Suk Cho[1,2], Hisashi Hayakawa[3], Yukinaga Miyashita[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Institute for Space-Earth Environmental Research, Nagoya University*

11:55 [VII-1-7]

Discovering Empirical Relationships from Data by Symbolic Regression: Examples in Solar Physics and Space Weather

Yong-Jae Moon[1,2], Youngjae Kim[1], Seungwoo Ahn[1], Jihyeon Son[3]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Space Science , Kyung Hee University*
[3]*Korea Astronomy and Space Science Institute*

릴리 I

10:25 [VII-2-1]

K-RadCube: A 12U Secondary Payload for NASA's Artemis II to Measure Space Radiation in the Van Allen Belts

Chae Kyung Sim[1,2], Young-Jun Choi[1], Dukhang Lee[1,2], Jehyuck Shin[1], Donguk Song[1], Seul-Min Baek[1], Woohyeong Seol[1], K-RadCube Team

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

10:40 [VII-2-2]

System Development of K-RadCube: A 12U CubeSat for Space Radiation Measurement on NASA's Artemis II Mission

Seongwhan Lee[1], Hyojeong Lee[1], Chae Kyung Sim[2,3], Dukhang Lee[2,3], Jehyuck Shin[2], Donguk Song[2], Seul-Min Baek[2], Woo-Hyeong Seol[2], Uk-Won Nam[2], Young-Jun Choi[2], K-RadCube Team

[1]*Nara Space Technology Inc.*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

10:55 [VII-2-3]

Safety Assurance of K-RadCube as a Secondary Payload on the Artemis II Mission

Jehyuck Shin[1], Dukhang Lee[1,2], Hyojeong Lee[3], Seongwhan Lee[3], Donguk Song[1], Chae Kyung Sim[1,2], Seul-Min Baek[1], Uk-Won Nam[1], Woo-Hyeong Seol[1], Young-Jun Choi[1], Taewan Kim[4], Hyeonggu Kim[4], K-RadCube Team

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Nara Space Technology Inc.*
[4]*KT SAT*

11:10 [VII-2-4]

Lessons Learned from K-RadCube LEOP Operations

Donguk Song[1], Chae Kyung Sim[1,2], Dukhang Lee[1,2], Jehyuck Shin[1], Seul-Min Back[1], Woo-Hyeong Seol[1], Young-Jun Choi[1], Uk-Won Nam[1], Won-Kee Park[1], Kwangwon Lee[3], Hyojeong Lee[3], Seongwhan Lee[3], Taewan Kim[4], Hyeonggu Kim[4], K-RadCube Team

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Nara Space Technology Inc.*
[4]*KT SAT*

11:25 [VII-2-5]

K-RAD-PD LET Spectrometer for Radiation Belt Studies Using the K-RadCube Mission

Uk-Won Nam[1], Woo-Hyeong Seol[1], Won-kee Park[1], Sunghwan Kim[2], Sukwon Youn[3], Chae Kyung Sim[1,4], Dukhang Lee[1,4], Jehyuck Shin[1], Donguk Song[1], Seul-Min Back[1], Young-Jun Choi[1], Kwangwon Lee[5], Hyojeong Lee[5], Seongwhan Lee[5]

[1]*Korea Astronomy and Space Science Institute*
[2]*Cheongju University*
[3]*Seoul National University*
[4]*University of Science and Technology*
[5]*Nara Space Technology Inc.*

11:40 [VII-2-6]

K-RadCube's Subpayload of Samsung Explorative Memory and Logic Devices for Space Experiment

Jin-Woo Han[1], Youngseok Woo[1], Kyutae Kim[1], Uk-Won Nam[2], Chae Kyung Sim[2,3], Dukhang Lee[2,3], Jehyuck Shin[2], Donguk Song[2], Seul-Min Baek[2], Woo-Hyeong Seol[2], Young-Jun Choi[2]

[1]*Device Solutions CTO, Samsung Electronics*

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

11:55 [VII-2-7]

Comprehensive Analysis of In-Orbit Radiation Environment and Real-Time Degradation of DRAM Devices in an Elliptical Earth Orbit up to 70,000 km

Shingyu Choi[1], Sulhwan Lee[1], Uk-Won Nam[2], Chae Kyung Sim[2,3], Dukhang Lee[2,3], Jehyuck Shin[2], Donguk Song[2], Seul-Min Baek[2], Woo-Hyeong Seol[2], Young-Jun Choi[2]

[1]*SK hynix Inc.*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

포스터발표 논문 제목

4월 23일(목) 16:10~17:50

▶ 행성 과학

[P-1] A Preliminary Polarimetric Study of Lunar Surface Mineral Simulants

Eunji Yi[1,2], Chae Kyung Sim[1,2], Keewook Yi[3], Eunjin Cho[1], Minsup Jeong[1], Serin Kim[1,2]

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

[P-2] A Network-Based Approach to Lunar Magnetic Anomaly Observation Using Deployable M-Box Probes

Yesun Ahn[1], Jeonghwan Jang[1], Ho Jin[1], Hyeonhu Park[2], Minjae Kim[1], Sanghwa Kim[1], Khan-Hyuk Kim[1], Chae Kyung Sim[3]

[1]*School of Space Research, Kyung Hee University*
[2]*G-LAMP NEXUS Institute, Kyung Hee University*
[3]*Korea Astronomy and Space Science Institute*

[P-3] Opposition Effect on Highly Porous Silica Analogues Fabricated by 3D Printing

Mingyeong Lee[1], Minsup Jeong[1], Matthew J. Berg[2], Don Lin[3], Chae-Kyung Sim[1,4], Antti Penttilä[5], Karri Muinonen[5], Sungsoo S. Kim[6], Gorden Videen[7], Young-Jun Choi[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Kansas State University*
[3]*Oregon State University*
[4]*University of Science and Technology*
[5]*University of Helsinki*
[6]*Kyung Hee University*
[7]*Space Science Institute*

[P-4] Feasibility Study of a Crew-Deployable Magnetometer for Manned Lunar Surface Exploration

Minjae Kim[1], Ho Jin[1], Yunho Jang[1], Hyeonhu Park[2], Sanghwa Kim[1], Seul-Min Baek[3], Khan-Hyuk Kim[1]

[1]*School of Space Research, Kyung Hee University*
[2]*G-LAMP NEXUS Institute, Kyung Hee University*
[3]*Korea Astronomy and Space Science Institute*

[P-5] Inverse Estimation of Vertical Thermal Structure and Heat Source Parameters of Venus Atmosphere using PINNs

Hong-Ju Kwon, Yu Yi

Department of Astronomy and Space Science, Chungnam National University

[P-6] The Necessity of Concurrent Lunar Surface and Orbital Magnetic Field Measurements: Insights from Anomalous Phenomena

Sanghwa Kim[1], Ho Jin[1], Khan-Hyuk Kim[1], Peter J. Chi[2], Wooin Jo[1], Seul-Min Baek[3]

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

▶ 태양 및 우주환경

[P-7] Estimation of 557.7 nm Auroral Emission Altitude from Two-Station All-Sky Imaging at Jang Bogo Station and Cape Hallett

Ji Eun Kim[1], Hyuck-Jin Kwon[1], Changsup Lee[1], Young-Bae Ham[1,2], Yujin Cho[1,2], Geonhwa Jee[1,2]

[1]*Division of Atmospheric Sciences, Korea Polar Research Institute*
[2]*Department of Polar Sciences, University of Science and Technology*

[P-8] Large Thermospheric Wind Enhancements in the Polar Cap Observed at Jang Bogo Station during Substorm Expansion Phases

Eunsol Kim[1], Changsup Lee[1,2], Young-Bae Ham[1,2], Geonhwa Jee[1,2]

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

[P-9] Radial Evolution of Solar Wind Plasma Properties from 0.1 to 1 AU Using Parker Solar Probe and OMNI Data

Eunbi Yi[1], Sung-Hong Park[2,3]

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

[P-10] Statistical Analysis of High-Latitude Geomagnetic Disturbances Associated with Solar

Wind Conditions

Seohee Jang[1,2], Sung-Hong Park[1,2]

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

[P-11] Localized Density Duct Versus Banded Chorus Generation: Ray Tracing Analysis

Chaejeong Hong[1], Kyungguk Min[1,2,3]

[1]*Department of Earth, Environmental & Space Sciences, Chungnam National University*
[2]*Department of Astronomy and Space Science, Chungnam National University*
[3]*Institute for sciences of the Universe, Chungnam National University*

[P-12] Statistical Survey of He-Band EMIC Waves at Geosynchronous Orbit Observed by GK2A Across Solar Minimum to Maximum under Varying Geomagnetic Conditions

Minuk Kang[1], Kyungguk Min[1,2]

[1]*Department of Earth, Environmental & Space Sciences, Chungnam National University*
[2]*Department of Astronomy and Space Science, Chungnam National University*

[P-13] Initial Observations of Thermospheric Neutral Winds by a Newly Installed Bohyunsan FPI: Validation through Comparison with Meteor Radar and Response to Geomagnetic Storms

Jaewook Lee[1], Tae-Yong Yang[1], Young-Sil Kwak[1,2], Jeongheon Kim[1], Jongil Jung[1]

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

[P-14] Influence of Tropospheric Variability on Migrating Semidiurnal Tide in the Mesosphere and Lower Thermosphere

Kyeongsoo Kim, In-Sun Song

Department of Atmospheric Sciences, Yonsei University

[P-15] Hemispheric Asymmetry in the Ionospheric Response to the January 2026 Geomagnetic Storm in the Asian Sector

Se-Heon Jeong[1], Hyosub Kil[1,2], Jeong-Heon Kim[1], Jaewook Lee[1], Woo Kyoung Lee[1,3], Young-Sil Kwak[1,3]

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

[P-16] Solar Wind Conditions Associated with Large East-West Asymmetries in Proton Flux (>10 MeV) Observed by GOES

Seunghyeon Lee[1,2], Sung-Hong Park[1,2]

[1]*Korea Astronomy and Space Science Institute (KASI)*
[2]*University of Science and Technology (UST)*

[P-17] Deep Learning-Based Detection of Ionospheric Plasma Irregularities Using VHF Radar Observations

Jonghoon Lee[1], Ji-Hye Lee[1], Yunhee Choi[1], Jieun Ahn[1], Jung-Hoon Kim[1], Hyeon-Deok Jo[2], Hong-Sin Kwak[3]

[1]*SETsystem, Inc.*
[2]*Republic of Korea Air Force Weather Group,*
[3]*Republic of Korea Air Force Space Operations Group*

[P-18] Observation of Polar Cap Patches Using an All-Sky Camera at Jang Bogo Station, Antarctica

Yujin Cho[1,2], Geonhwa Jee[1,2], Young-Bae Ham[1,2]

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

[P-19] Characteristics of Ionospheric Tilts Associated with Electron Density Variations Observed by VIPIR/Dynasonde at Jang Bogo Station, Antarctica

Minyeong Kim[1,2], Geonhwa Jee[1,2], Young-Bae Ham[1,2], Junho Back[1], Hyuck-Jin Kwon[1], Changsup Lee[1]

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

[P-20] A Preliminary Study of Limb Flare Forecasting Using EUV Images and Explainable AI

Hyunnam Kim[1], Yong-Jae Moon[1,2]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

[P-21] Multiscale Structure of Near-Sun Heliospheric Current Sheet Crossings: Large-Scale Envelopes and Embedded Small-Scale Current Sheets Observed by Parker Solar Probe

Dooyoung Choi, Dae-Young Lee, Kyung-Chan Kim
Chungbuk National University

[P-22] Transient Brightenings as Pre-Flare Precursors: Preliminary Result

Woncheol Joo[1], Youngjae Kim[1], Yong-Jae Moon[1,2]
[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

[P-23] Periodicity Analysis of Pulsating Aurora Using High-Temporal-Resolution NIR Images from e-POP/FAI

Se Rin Jeon[1,2], Woo Kyoung Lee[1,2], Hyosub Kil[1,3]
[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Johns Hopkins University Applied Physics Laboratory*

▶ 우주 응용 · 활용

[P-24] Study of Signal Variation with Lunar Position in the Geomagnetic Tail

Haingja Seo, Inae Jung, Hyewon Park
Korea Aerospace Research Institute

[P-25] Performance Evaluation of Onboard AI Compression for Solar Observation Data Transmission Using Jetson Orin Nano

Na-Yeong Hwang[1,2], Jaewon Lee[1,3], Yong-Jae Moon[1,2,4]
[1]*School of Space Research, Kyung Hee University*
[2]*G-LAMP NEXUS Institute, Kyung Hee University*
[3]*Korea AeroSpace Administration*
[4]*Department of Astronomy and Space Science, Kyung Hee University*

[P-26] An Analysis of Standard Payload Rack Requirements for Undersea Platforms

Joohee Lee, Younkyu Kim, Ikhyeon Choi
Korea Aerospace Research Institute

▶ 우주 광통신

[P-27] Development of a Dual-Beam Tracking System for Optical Wireless Communication and Its Application to Satellite Gimbals

Jae-Seong Shin[1], Junoh Lee[1], Yeongho Shin[2], Sunghoon Cho[2], Dongsoo Choi[2], Sun-Je Kim[1]
[1]*School of Electrical Engineering, Soongsil University*
[2]*JUSTEK, Inc.*

▶ 우주 천문

[P-28] AI-Based TIF Depth and Volume Prediction for Space Optical Materials

Youngseok Lee[1,2], Jeong-Yeol Han[1,2], Seung Ho Han[1,2], Jiwoo Lee[1,2]
[1]*University of Science and Technology*
[2]*Korea Astronomy and Space Science Institute*

▶ 우주 산업 · 인프라

[P-29] Improving the Performance of Low Vacuum Pumps in Small-Sized Thermal Vacuum Chamber

Sung-wook Park
Korea Aerospace Research Institute

[P-30] Physical Interpretation of Launch Shock Based on Impulse and Structural Dynamic Response

Jong-Hyub Jun, Jong-Min Im, Hee-Kwang Eun, Nam-Jin Moon, Seon-Je Jo, Jin Park, Chang-Rae Cho, Tae-Seok Oh
Korea Aerospace Research Institute

[P-31] Establishing a High-Precision Vacuum Measurement System via Uncertainty Evaluation and Verification of Vacuum Sensors

Ji-Hoon Choi, Hee-jun Seo, Seon-gi Baek, Geun-sik Kim, Seong-uk Park, Ji-seok Kim, Gyu-min Oh, Seung-mo Hong
Korea Aerospace Research Institute

[P-32] Design Study of a High-Efficiency Thermal Radiation Device through Measurement and Analysis of Thermal Conductivity of Copper Plates by Connection Methods

Keun-Shik Kim, Ji-Seok Kim, Sung-Wook Park, SunKi Baek, Hee-Jun Seo, Ji-Hoon Choi, KyuMin Oh

Korea Aerospace Research Institute

[P-33] Automation of the Lifting System Working Platform for a Large Thermal Vacuum Chamber and Surface Machining of the Approach Fixture Working Platform

SunKi Baek, Sung-Wook Park, KeunShik Kim, Hee-Jun Seo, Ji-Seok Kim, Ji-Hoon Choi, KyuMin Oh

Korea Aerospace Research Institute

[P-34] Analysis of Dynamic Characteristics for a 2 m Head Expander for Satellite Vibration Testing

Jong-Min Im, Hee-Kwang Eun, Tae-Seok Oh

Korea Aerospace Research Institute

[P-35] Evaluation of IPA Reference Peak Deviations with Varying Relative Humidity in FT-IR-Based Satellite Molecular Contamination Measurements

Seungmo Hong, Sungwook Park, Gyumin Oh, Jihoon Choi

Korea Aerospace Research Institute

[P-36] A Study on Measurement System Configuration for Satellite Acoustic Tests Using a Large Acoustic Chamber

Jin Park, Jongmin Lim, Namjin Moon, Seonje Jo

Korea Aerospace Research institute

[P-37] Design and Implementation of a Control and Monitoring System for Orbit Environment Tests of Satellite System and Component

Heejun Seo, Sungwook Park, Jiseok Kim

Korea Aerospace Research Institute

▶ 우주 시스템 체계

[P-38] CAP-C Payload Electrical Test Bed (ETB) Configuration of the CAS500-5 Satellite

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[1]*G-LAMP NEXUS Institute / School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

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[1]*Korea Aerospace Research Institute*
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[2]*University of Science and Technology*
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[1]*Chungbuk National University, Korea*
[2]*ISEE, Nagoya University, Japan*
[3]*University of Tokyo, Japan*
[4]*Seoul National University, Korea*
[5]*Research Institute for Humanity and Nature, National Institutes for the Humanities, Japan*

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[1]*Korea Aerospace Research Institute*
[2]*Asia Pacific Satellite Inc.*

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[2]*University of Science and Technology*

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[1]*Korea Aerospace Research Institute*
[2]*SATREC INITIATIVE*

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Hosub Song[1], Dae-Hee Lee[1,2,3], Jaejin Lee[1]
[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Aerospace Engineering KAIST*
[3]*Department of Astronomy and Space Science, University of Science and Technology (UST)*

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Hyeongu Lim, Kilyong Hwang, Jongguk Choe, Jeoungheum Yeon

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Sung-Woo Park[1], Jeong-Hun Kim[1], Hyoung-Jun Jang[2]

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[2]*Korea Aerospace Industry*

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[2]*Korea Advanced Institute of Science and Technology*

[P-91] Korean Positioning System, KPS, Payload Mechanical Design Integration

Hanjun Lee[1], Joongpyo Kim[1], Dai-Ho Ko[1], Won-Beom Lee[1], Ki-Lyong Hwang[1], Hyun-Ho Kwak[2], Younghoon Choi[2]

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구두발표 논문 초록

4월 22일(수) 그랜드볼룸 I

Invited Talk I

Chair: 곽영실(천문연)

13:20 [IS-1]

Navigating the Invisible Frontier: The Science of Radiation in Space Exploration

Insoo Jun

Seoul University

Behind the veil of seemingly endless emptiness, invisible radiation permeates every space mission. These energetic particles originate from diverse sources: the Sun's dynamic activity, Galactic Cosmic Rays (GCRs) from deep space, and the Earth's own trapped radiation belts. Understanding space radiation is an inherently multidisciplinary challenge. Deciphering its fundamental nature is a core scientific endeavor, while mitigating its harmful effects on spacecraft and astronauts demands cutting-edge technological and engineering innovation. In this talk, I will provide a comprehensive overview of the space radiation environment, tailored for the Korean space science community. The presentation will bridge the gap between scientific disciplines—including heliophysics, magnetospheric physics, and planetary science—and essential engineering domains, such as radiation effects on electronics and advanced shielding strategies. For each area, I will summarize the current state-of-the-art and highlight the active research frontiers that are defining the future of space exploration. To conclude, I will present NASA's Europa Clipper mission as a prime example of a radiation-intense exploration. I will discuss its mission history, scientific goals and objectives, and the sophisticated spacecraft and instrument design required to overcome the extreme radiation challenges posed by the Jovian system.

그랜드볼룸 I

I-1 우주물리 I

Chair: 나고운(경희대)

14:00 [I-1-1]

Measurement of the Underground Muon Flux at Y2L and Yemilab with the COSINE-100 and COSINE-100U Experiments

Moo Hyun Lee[1,2], Luis E. F. Franca[3] for COSINE-100 collaboration

[1]*Institute for Basic Science (IBS)*
[2]*University of Science and Technology (UST)*
[3]*University of Sao Paulo, Brazil*

The muon veto systems of the COSINE-100 and its upgraded successor, COSINE-100U, consist of 37 plastic scintillator (PS) panels that provide 4π coverage of the detector. COSINE-100 operated from September 2016 to March 2023 at the YangYang Underground Laboratory (Y2L) in South Korea, which is located at an effective depth of approximately 1,800 meters water equivalent. An initial study of the underground muon flux at Y2L was performed using the first 2.6 years of COSINE-100 data, including a measurement of the muon flux and its annual and diurnal modulations. The next phase of the experiment, COSINE-100U, began operating in September 2025 at Yemilab, located at an effective depth of approximately 2,500 meters water equivalent. In this contribution, we present updated measurements of the muon flux at Y2L based on 6.5 years of COSINE-100 data, as well as the first results on the muon flux at Yemilab obtained with the COSINE-100U detector.

14:15 [I-1-2]

Muon Flux at Yemilab for AMoRE-II

Go Woon Kim
(on behalf of the AMoRE Collaboration)

Center for Underground Physics, Institute for Basic Science

The AMoRE project searches for the neutrinoless double beta decay of ^{100}Mo using molybdate scintillation crystals and cryogenic detection. AMoRE-II, the second phase of the project, will be conducted at Yemilab, a new underground laboratory in Jeongseon, Gangwon-do. To achieve the target sensitivity of AMoRE-II (8×10^{26} yr), a near-zero background level is required. Yemilab is located underground with an overburden depth of 1,000 m, and this depth provides a muon flux reduction by a factor of 10^5 compared to the surface. However, high-energy cosmic muons can still reach the experimental area and affect the experiment by inducing background events. Therefore, an effective muon veto system is essential to identify muons and reject their associated backgrounds.
The muon veto system for AMoRE-II consists of two components: a plastic scintillator muon detector (PSMD) and a water Cherenkov muon detector (WCMD). The construction is complete, and data taking is currently ongoing. The preliminary muon flux obtained by the system is $\sim 8.2 \times 10^{-8}$ muons/cm^2/s. In this talk, the configuration of the muon veto system, its operation, and data analysis procedures will be presented.

14:30 [I-1-3]

Measurement of Cosmic-Ray-Induced Neutron Spectra at Ground Level Using a High-Sensitivity

^{3}He Neutron Spectrometer

Young Soo Yoon, Joong Hyun Kim, Jungho Kim, Hyeonseo Park, Sinchul Kang

Korea Research Institute of Standards and Science

Cosmic-ray-induced secondary neutrons at ground level serve as a critical, dynamic probe for understanding Galactic Cosmic Ray (GCR) variations, while also driving significant radiation impacts in terrestrial electronics. Accurate knowledge of the neutron energy spectrum and fluence is therefore essential for evaluating radiation impacts on electronic systems. In this study, we present measurements of the cosmic neutron spectrum performed using a high-sensitivity neutron spectrometer based on a He-3 proportional counter combined with polyethylene moderators.

The spectrometer was deployed at several measurement sites with different altitudes to investigate variations in the neutron environment associated with atmospheric depth. By applying advanced spectral unfolding techniques to the complex detector responses, precise neutron fluences were reconstructed across thermal, fast, and high-energy regimes. Differences in the neutron flux with altitude were analyzed and compared among the measurement locations.

14:45 [I-1-4]

Enhancement of Radiation-Hardened Semiconductor Evaluation Infrastructure and Testing Facilities Using High-Energy Cosmic-Ray Analysis Techniques

Jeong Min Park, Chang Goo Kang, Yongsu Lee

Korea Atomic Energy Institute, Advanced Radiation Technology Institute

Ensuring the reliability of semiconductor devices against extreme cosmic ray is a critical requirement for advanced space missions. This presentation outlines the current progress in upgrading radiation-hardened semiconductor evaluation systems and testing infrastructure, leveraging expertise in high-energy particle analysis and detector operations gained from prior cosmic-ray observation projects such as ISS-CREAM (Cosmic Ray Energetics And Mass on International Space Station.)

The core of this work involves optimizing beamlines and establishing precision measurement systems at ground-based accelerator facilities to more accurately simulate the physical characteristics of the space radiation environment. By integrating particle physics measurement protocols into Single Event Effects (SEE) and Total Ionizing Dose (TID) characterization processes, we have enhanced the fidelity of device reliability assessments. Currently, performance evaluations for key radiation-hardened components are being conducted using domestic radiation testing facilities, alongside ongoing system upgrades to align accelerator environments with actual space-borne radiation spectra. This paper shares the current status of how cosmic-ray measurment techniques are being extended and applied to the infrastructure for semiconductor reliability assessment.

15:00 [I-1-5]

Introduction of the Space Radiation Test Facility at the KOMAC for Cosmic Ray Detection Systems

Young Seok Hwang, Myung-Hwan Jung, Yu-mi Kim, Jun Mok Ha

Korea Atomic Energy Research Institute (KAERI)

Understanding the origin and propagation of high-energy cosmic rays is a central challenge in modern astrophysics. The ISS-CREAM experiment operated aboard the International Space Station for 539 days, directly measuring energy spectra of protons, helium, and heavier nuclei. The Silicon Charge Detector (SCD) consists of four layers, achieving charge identification accuracy above 99%. In conjunction with the calorimeter (CAL), the SCD provides high-energy triggers (EHI) for cosmic-ray events. In parallel, the Top Counting Detector (TCD) and Bottom Counting Detector (BCD) serve as low-energy triggers (ELO) and enable effective separation of protons and electrons. For long-duration missions, the reliability of these detectors must be ensured through radiation effects testing, particularly Total Ionizing Dose (TID) evaluations.

The Korea Multi-Purpose Accelerator Complex (KOMAC), operated by KAERI in Gyeongju, offers a 100-MeV proton linear accelerator, a low-flux beam line (TR102). Registered in the JEDEC JESD89B standard and compliant with ESA and MIL-STD requirements, KOMAC is Korea's sole internationally accredited space radiation test facility. These facilities will continue to contribute to future studies by providing ground-based radiation effects testing for detectors such as SCD and TCD/BCD, thereby supporting long-term mission reliability and radiation hardness assurance.

릴리 I

I-2 Numerical Models of Heliospheric Space Environment

Chair: 김수진(천문연)

14:00 [I-2-1]

Conceptual Study on the Development of a Numerical Model for the Heliospheric Space Environment

Jungjoon Seough[1], Sungjung Kim[2], Junmo An[2], Sibaek Yi[2], Ryun-Young Kwon[1], Jinho Kim[1], Sujin Kim[1], Young-Sil Kwak[1], Yong-Jae Moon[2], Dongsu Ryu[3]

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

This study presents a conceptual framework for developing an integrated numerical modeling system of the heliospheric space environment. The proposed system is built upon a physics-based heliospheric MHD model to simulate the propagation of solar wind and coronal mass ejections (CMEs), coupled with a Solar Energetic Particle (SEP) model to predict particle acceleration and transport in the heliosphere. Artificial Intelligence (AI) techniques are proposed to use observational data and numerical simulation outputs to optimize boundary conditions, accelerate model computations, and correct forecast errors, thereby enhancing forecasting capability. The framework also includes the development of an integrated operational platform that connects modeling, validation, data assimilation, and visualization. This approach aims to establish a next-generation heliospheric space weather prediction system combining physics-based modeling and AI-driven enhancement.

The increasing impact of solar activity on space- and ground-based technological systems highlights the urgent need for a comprehensive and predictive heliospheric space weather modeling framework. This study presents a conceptual framework for developing an integrated numerical modeling system of the heliospheric space environment. The proposed framework is centered on a physics-based Heliospheric Magnetohydrodynamic (MHD) model, which simulates the large-scale propagation of solar wind structures and coronal mass ejections (CMEs) from the solar corona to planetary environments. The MHD model provides time-dependent plasma and magnetic field parameters throughout the heliosphere, forming the backbone of the forecasting system. To address radiation hazards associated with solar eruptive events, a coupled Solar Energetic Particle (SEP) model is incorporated. The SEP model describes particle acceleration and transport processes based on focused transport theory, utilizing shock and magnetic field information derived from the MHD simulations. This MHD–SEP coupling enables self-consistent prediction of particle fluxes, onset times, and energy spectra at various heliospheric locations. In addition to physics-based modeling, Artificial Intelligence (AI) techniques are proposed to use observational data and numerical simulation outputs to optimize boundary conditions, accelerate model computations, and correct forecast errors, thereby enhancing forecasting capability. We discuss the overall concept of the proposed modeling framework, its key components and coupling strategies, and its potential to support next-generation heliospheric space weather forecasting.

14:15 [I-2-2]

Development Strategy for a Korean Heliospheric MHD Model: Numerical Methods Survey and AI-Based Enhancement Approaches

Junmo An[1], Jungjoon Seough[2]

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

Heliospheric magnetohydrodynamic (MHD) models are essential tools for predicting the propagation of the solar wind and coronal mass ejections (CMEs) in space weather forecasting. Operational models such as WSA–ENLIL, SUSANOO, and EUHFORIA are widely used for real-time predictions. In Korea, the WSA–ENLIL model is currently used for operational forecasting; however, limited access to its source code and restricted capability for modification pose challenges for further development. These limitations highlight the need for an independent heliospheric modeling framework that can reflect the needs of researchers in Korea and incorporate the latest observational data. As an initial step toward developing a Korean heliospheric MHD model, this study surveys numerical methods used in existing models and outlines a development strategy. We review numerical schemes commonly used in heliospheric MHD simulations, including Riemann-solver-based flux methods such as Rusanov, HLL/HLLE, and HLLD. Several grid systems used in global simulations—such as Cartesian, spherical, Yin-Yang, and cubed-sphere grids—are compared in terms of polar singularity issues, computational efficiency, GPU compatibility, and implementation complexity. Based on these analyses, we propose a stepwise development roadmap including numerical scheme design, boundary condition configuration, and computational module implementation. Potential AI-based approaches—such as improving model inputs, correcting model bias using in-situ observations, and estimating high-resolution outputs from lower-resolution simulations—are also discussed to enhance prediction accuracy and computational efficiency.

14:30 [I-2-3]

Current Status of Solar Corona Modeling and Strategies for Developing a Data-Driven Coronal MHD Code

Sibaek Yi[1], Jungjoon Seough[2]

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

This presentation reviews the current state of solar wind and coronal mass ejection (CME) models, which are indispensable components of heliospheric space environment simulations, and proposes strategies for developing a next-generation data-driven coronal MHD code. While empirical models such as WSA

provide high computational efficiency, they lack detailed physical representation. In contrast, physics-based models such as COCONUT, MAS, and AWSoM produce more realistic coronal structures. In particular, COCONUT provides an efficient framework for large-scale simulations using a fully implicit MHD scheme on unstructured grids.
Despite the existence of numerous empirical CME models, they have inherent limitations for real-time forecasting, including oversimplified structures and the inability to capture interactions with the background solar wind. Flux rope insertion methods are widely used due to their improved physical realism. however, they are not fully self-consistent physical models because they rely on artificial eruption triggers and free parameters.
To address these limitations, we are developing a coronal MHD code designed to extend the capabilities of existing models such as COCONUT. The new model will incorporate Alfven wave pressure and heating mechanisms to improve the physical representation of solar wind acceleration. Furthermore, we aim to establish a data-driven CME model that unifies solar wind generation and CME initiation within a single self-consistent physical framework.

14:45 [I-2-4]

PHAROS: Development of a Radiation-MHD Code for Multi-Layer Simulations of the Solar Atmosphere

Donghui Son[1], Tetsuya Magara[1,2]

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

Realistic simulations of the solar atmosphere require a numerical framework that self-consistently couples compressible magnetohydrodynamics, realistic thermodynamics, radiative energy transport, and thermal conduction. We present PHAROS (Parabolic-Hyperbolic Advanced Radiation-MHD for astrophysical ObjectS), a radiation-MHD code under development for multi-layer simulations extending from the convection zone to the corona. PHAROS solves the radiative-MHD equations in a unified framework, incorporating radiative heating and cooling, field-aligned thermal conduction, and resistivity. We describe the numerical design and current status of the code and present representative results that demonstrate its capability for realistic modeling of the solar atmosphere.

15:00 [I-2-5]

Toward a GPU-Accelerated Hybrid Test-Particle and Stochastic Transport Framework for Solar Energetic Particle Modeling

Sunjung Kim[1], Jungjoon Seough[2]

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

Solar energetic particles (SEPs) are a major driver of space weather and can significantly affect spacecraft operations, astronaut safety, and space-based technologies. Numerical modeling of SEP acceleration and transport in the heliosphere is therefore essential for understanding the underlying physical processes and for improving predictive capabilities. Current SEP simulations are generally based on three main approaches: full-orbit test-particle simulations, focused transport equation (FTE) models, and stochastic differential equation (SDE) methods. Test-particle simulations resolve particle gyromotion through direct integration of the Lorentz equation, but they require extremely large particle numbers for statistical convergence and remain computationally expensive for large-scale heliospheric propagation. In contrast, SDE approaches can efficiently describe global SEP transport across astronomical-unit scales, but they rely on parameterized diffusion coefficients and do not directly resolve microphysical processes such as shock acceleration and wave-particle interactions.
In this presentation, we propose a GPU-accelerated hybrid modeling framework intended to combine the strengths of both approaches. In the proposed framework, large-scale SEP propagation in the heliosphere would be treated using an SDE-based Monte Carlo transport solver, while particle acceleration at CME-driven shocks would be described by local test-particle simulations. When SDE pseudo-particles encounter a shock region, they would be converted into local particle ensembles to evaluate acceleration processes such as shock drift acceleration and diffusive shock acceleration, and the resulting accelerated spectra would then be reinjected into the global SDE transport solver.
This framework is expected to be well suited for massively parallel GPU architectures and to enable efficient simulations of large particle ensembles. It is intended to serve as a foundation for the development of a next-generation physics-based SEP model and may ultimately contribute to near-real-time space weather forecasting.

15:15 [I-2-6]

Particle-in-Cell Simulations to Probe Wave-Particle Interactions in the Inner Magnetosphere

Kyungguk Min[1,2,3]

[1]*Department of Astronomy and Space Science, Chungnam National University*
[2]*Department of Earth, Environmental & Space Sciences, Chungnam National University*
[3]*Institute for Sciences of the Universe, Chungnam National University*

The particle-in-cell (PIC) method is a numerical framework to solve the Vlasov-Maxwell system of equations that are widely used to probe kinetic physics in space and laboratory plasmas. The main goal of this talk is to highlight applications of the PIC method to plasma waves and wave-particle interactions in the inner magnetosphere. There, a PIC code (and its variants such as hybrid code) is an extensively used, indispensable tool to study the wave generation in kinetic scale from an unstable source distribution (e.g., EMIC and chorus waves), its propagation along and across field lines, and its influence in the ambient plasma (wave-particle interaction). We introduce common assumptions used for the inner magnetospheric environment and approaches to adopt curved field geometry and inhomogeneous background magnetic field and plasma density, followed by example studies published in literature. This will be followed by some suggestions on what we as community need to focus on and to which we should invest our limited resources for future magnetospheric study.

릴리 II

I-4 안보우주 I

Chair: 최호성(육군)

14:00 [I-4-1]

Operational Concepts of Mobile Ground-Based Laser Counter-Satellite System for ROK Army

Ho-Sung Choi[1], Inchan Lee[1], Yujung Roh[1,2], Kangwoo Kim[3]

[1]*Republic of Korea Army*
[2]*Korea Astronomy and Space Science Institute*
[3]*2nd Operation Command, Republic of Korea Army*

This study examines the military necessity, operational applications, and global trends surrounding maneuverable counter-space laser systems designed to dazzle or blind hostile optical satellites. As space-based intelligence, surveillance, and reconnaissance (ISR) assets become central to modern warfare, armed forces increasingly require non-kinetic, reversible, and scalable response options. Optical counter-space systems—often described as satellite dazzling or blinding capabilities—offer a means to temporarily degrade adversary imaging satellites without creating orbital debris, distinguishing them from kinetic anti-satellite (ASAT) weapons.

The study analyzes operational concepts such as mobile ground-based laser units, rapid targeting and tracking integration, rules of engagement, and proportional response frameworks. It also reviews international developments, including reported capabilities in the United States, China, and Russia, alongside evolving legal and normative debates under the Outer Space Treaty. By assessing strategic utility, escalation risks, and compliance considerations, the presentation highlights both the deterrent value and the policy challenges of deploying maneuverable optical counter-space laser systems in contemporary military doctrine.

14:15 [I-4-2]

Evolution of the Space Security Environment and Trends in Anti-Satellite (ASAT) Technology Development

Yujung Roh[1,2], Hyung-Chul Lim[2], Ki-pyung Sung[2], Eojin Kim[2], Gwibong Kang[2], Ho-Sung Choi[1]

[1]*Republic of Korea Army (ROKA)*
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Space has increasingly emerged as a critical strategic domain in modern military operations and national security. As various functions such as reconnaissance, communication, and navigation have become highly dependent on satellite systems, the importance of space assets has grown significantly. Consequently, major countries are actively developing anti-satellite (ASAT) technologies aimed at neutralizing or restricting the capabilities of adversary satellites. This study aims to analyze the types of threats faced by satellite assets within the evolving space security environment and to systematically examine the development trends and technical characteristics of major ASAT technologies.

First, the study compares threat characteristics according to satellite orbital regimes and mission types. It also provides an overview of various ASAT technologies currently under development, including direct-ascent interception, co-orbital attacks, electromagnetic jamming, and cyber operations. Among these approaches, particular attention is given to non-destructive attack technologies that minimize the generation of space debris. In this context, ground-based high-energy laser systems—considered one of the most technically feasible ASAT technologies—are examined in greater detail.

In discussing laser-based ASAT technologies, this study reviews satellite tracking techniques and atmospheric distortion correction using adaptive optics (AO), which can improve the efficiency of laser energy delivery to space targets. Furthermore, the potential effects of laser irradiation on optical sensors, including sensor saturation, pixel damage, and thermal damage, are analyzed. By comprehensively examining the threat landscape to space assets and the development trends of ASAT technologies, this study highlights the importance of satellite defense strategies and the enhancement of space situational awareness capabilities in the future space security environment.

14:30 [I-4-3]

A Study on the Propagation Characteristics of High-Power Lasers and Their Effects on Satellite Optical Systems

Ki-pyung Sung

Korea Astronomy and Space Science Institute (KASI)

The growing strategic importance of satellite-based Intelligence, Surveillance, and Reconnaissance (ISR) assets has fundamentally reshaped modern defense and security architectures. High-resolution optical imaging satellites are extensively employed for persistent monitoring of ground and maritime targets, providing decision-critical strategic information across a broad spectrum of national security applications. Consequently, the ability to deny, degrade, or disrupt adversarial optical reconnaissance capabilities has emerged as a subject of considerable operational and scientific interest. Among the countermeasure technologies currently under investigation, high-power lasers are regarded as a particularly promising approach, owing to their precision engagement, speed-of-light delivery, and scalable energy output.

However, the effective employment of ground-based high-power laser systems against orbital targets is fundamentally constrained by atmospheric propagation effects. As high-power laser beams traverse the Earth's atmosphere along slant paths toward satellite altitudes, they are subject to a complex interplay of physical phenomena, including diffraction-induced beam divergence, wavefront distortion caused by atmospheric turbulence, and energy attenuation resulting from molecular absorption and aerosol scattering. Nevertheless, depending on the irradiance level reaching the optical imaging sensor and the specific characteristics of the sensor's optical system, dazzling and blinding effects may occur, rendering high-power lasers a viable means of denying or degrading adversarial optical reconnaissance capabilities.

This study investigates the potential dazzling and blinding effects induced on satellite electro-optical sensors under high-power laser irradiation. The aim is to advance the quantitative understanding of high-power laser–electro-optical sensor interactions and to establish a physically grounded basis for the development of directed-energy countermeasure strategies targeting space-based ISR assets.

14:45 [I-4-4]

High-Repetition-Rate Petawatt Femtosecond Laser Platform for Laser-Induced Plasma Orbit Control of Space Objects

Tae Jun Yu[1,2], Doyoun Yu[2], Jaejin Lee[2], Dooyong Lee[1], Youngkwang Jung[1], Wooseok Choi[1], Geonhui Lee[1], Daewoong Park[1], Seungjin Hwang[1], Sungyoon Lee[1]

[1]*HIL Lab. Inc.*

[2]*Department of Advanced Divergence, Handong Global University*

Laser-induced plasma (LIP) and ablation have been widely discussed as promising mechanisms for imparting momentum to space objects for orbit modification and space debris mitigation. However, when the laser is deployed on the ground, the achievable fluence at the target is severely limited by beam propagation through the atmosphere and by the large engagement distance, typically to the level of only a few mJ/cm^2 on the object surface. Under such constrained fluence, conventional nanosecond high-energy lasers face intrinsic limitations in generating sufficiently high ablation pressure and impulse, mainly due to relatively high ablation thresholds and strong plasma shielding in the nanosecond regime. This motivates the use of femtosecond petawatt-class laser pulses, where higher peak intensities at comparable fluence enable more efficient plasma generation and ablation-driven impulse.

In this work, we discuss system-level laser requirements for laser-induced plasma based orbit control, focusing not on orbital mechanics or atmospheric turbulence, but on the laser platform itself. Starting from simple orbit-change scenarios for representative space objects, we translate the required Δv and accumulated impulse into practical laser parameters such as pulse energy, repetition rate, and fluence on target. This back-of-the-envelope scaling indicates that, for meaningful orbit modification on reasonable time scales, a high-repetition-rate femtosecond system delivering joule-level pulses at hundreds of hertz, with petawatt-level peak power after compression, is highly desirable. We then argue that a Ti:sapphire-based chirped-pulse amplification architecture remains the most suitable candidate for such a petawatt platform, owing to its broad gain bandwidth and capability for sub-100-fs pulse generation. The key challenge is not peak power itself, but sustaining high pulse energy at high repetition rate. This immediately leads to stringent requirements on the green pump source at 532 nm: multi-joule pulse energy, hundreds-of-hertz repetition rate, high beam quality, and excellent temporal and pointing stability. Consequently, the development of high-energy, high-repetition-rate nanosecond Nd:YAG pump lasers at 1,064 nm, followed by efficient frequency doubling to 532 nm, becomes a central technological bottleneck for practical LIP-based orbit control.

We outline a possible laser development roadmap from the perspective of solid-state laser engineering. This includes high-average-power Nd:YAG amplifier chains, advanced thermal management, beam quality preservation at high fluence, and robust frequency-conversion schemes that maintain efficiency and crystal lifetime at elevated repetition rates. Based on these considerations, we propose realistic parameter windows for future ground-based laser systems aimed at space-object impulse coupling, and identify critical research topics that bridge current petawatt-facility technology (typically operating

at only a few hertz) to the high-repetition-rate regime needed for space applications. The goal of this contribution is to provide the space science community with physically grounded boundary conditions for laser-induced plasma orbit control, while highlighting specific laser-technology challenges that must be solved to make such concepts operational.

15:00 [I-4-5]

Development of Fiber Lasers in APRI for Space and Defense Applications

Changsu Jun

Advanced Photonics Research Institute, GIST

Fiber lasers are increasingly being used in space and defense sectors because they offer scalable power along with excellent beam quality, allowing for long-distance targeting. Coherent beam combining of fiber lasers adds an additional level of power scaling beyond what spectral beam combining can achieve. High-power pulsed fiber lasers are capable of disabling EO/IR sensors. Laser power beaming is also an emerging technology for remotely charging UAVs both on Earth and in space, as well as for energy harvesting in space. When integrated with AI techniques, fiber lasers can enhance analysis, adaptive control, and overall performance. This work will present various fiber lasers in APRI designed for space and defense applications.

15:15 [I-4-6]

Optical Coatings for High-Power Laser Mirrors and Satellite Constellation Mirrors

June Park, Haeng-Yun Jung, Young Bok Kim, Euisam Lee, Seung Heon Han

Korea Photonics Technology Institute

Optical coatings are thin films deposited on optical substrates that utilize light interference arising from variations in refractive index and thickness of the thin films, thereby enhancing the reflective or transmissive properties of optical materials. In recent years, within the aerospace and defense sectors, increasing attention has been given to highly reflective mirrors and mirrors capable of operating under extreme space environments. High-reflectivity mirrors are typically fabricated by stacking dielectric materials in multilayer thin-film structures, which minimize optical transmission and achieve very high reflectance. These mirrors are mainly used in high-power laser systems. In contrast, reflective mirrors used in spaceborne optical systems for satellite constellations generally exhibit lower reflectivity than those used for high-power lasers, but they are designed with metallic coatings combined with protective overcoats to ensure stable operation under harsh space conditions, including low temperatures and high radiation environments. In this presentation, we discuss the different types of reflective mirrors whose designs vary according to their functional requirements, as well as fabrication methods and coating technologies.

This work was supported by the Technology Innovation Program (Development of highperformance Earth observation optical modules for massproducible dualuse (civilian and military) loworbit constellation satellites) (2410013439) funded By the Ministry of Trade, Industry & Energy (MOTIE, Korea).

그랜드볼룸 I

II-1 우주과학 탐사선

Chair: 이은상(경희대)

15:40 [II-1-1]

Heliospheric Physics Probe Development Strategy

Jaehong Park

Korea AeroSpace Administration

Korea AeroSpace Administration (KASA) plans to develop a Heliospheric Physics Probe and its payloads to conduct cis-lunar space environment observations while also demonstrating lunar orbit insertion using the next-generation launch vehicle. Leading spacefaring nations, such as the United States, European countries, and the United Kingdom, already regard the space environment as an essential element for national security and critical infrastructure protection, and KASA is preparing to expand Korea's exploration beyond the Moon toward deep space, including the Sun-Earth L4 point and Mars. Although Korea has about 30 years of experience in space science missions, most activities have focused on low Earth and geostationary Orbits, so dedicated precursor missions for payload and flight validation in deep space are indispensable. This presentation outlines the resulting development directions for KASA's future space science explorer missions.

15:55 [II-1-2]

Introduction to Korean Space Science Exploration Mission Design

Hyuchung Bang[1], Kyungwook Min[2,3], Kwangsun Ryu[2], Jinsung Lee[4], Dongheon Lee[1], Kyungsun Park[5], Jaeheung Park[6], Jaehong Park[7], Jongyeop Park[6], Seulmin Baek[6], Jaeheung Han[1,2], Daehyun Hwang[8], Woong-Rae Rho[9]

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[7]*Korea AeroSpace Administration*
[8]*Perigee Aerospace Inc.*
[9]*Korea Aerospace Research Institute*

Korea is preparing its first dedicated cislunar space-science exploration mission, designed to fill a critical gap in the global magnetospheric observation network. The mission's primary objective is the first systematic, long-duration *in-situ* exploration of the deep magnetotail (40–100 Earth radii, RE), a vast region that has remained virtually uncharted since the dawn of the space age. The mission is organized around four science goals: (1) revealing the structure and dynamics of deep magnetotail energy storage and release, (2) observing the large-scale development of KHI at the magnetopause–solar-wind boundary, (3) quantifying solar-wind heavy-ion (O^{6+}) entry and mass-transfer processes via a time-of-flight heavy-ion composition analyzer (HICA), and (4) acquiring solar and cislunar space-environment data to advance space-weather forecasting models. The mission also serves as a stepping stone toward Korea's long-term deep-space exploration roadmap, including L4 solar observation, lunar landing, and Mars missions, by providing flight heritage for the next-generation launch vehicle, deep-space navigation, and long-duration spacecraft operations beyond Earth orbit. This presentation introduces the mission rationale, the national policy context, and the international landscape of magnetospheric and planetary exploration within which the Korean mission is positioned.

16:10 [II-1-3]

The Korea-Led L4 Mission: Science Objectives and Payload Concepts for Heliophysics and Space Weather Forecasting

K.-S. Cho[1,2], KASI L4 Feasibility Study Team

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

The Sun–Earth Lagrange point L4, located 60° ahead of Earth, provides a persistent off-Sun–Earth-line perspective currently unoccupied by any heliophysics observatory. Combined with existing and planned assets at L1 and L5, this vantage point enables stereoscopic tracking of solar eruptions from their origin to 1 AU, filling a critical gap in space weather monitoring for Earth, cislunar, and deep-space environments. The Korea-led L4 mission organized around three science themes: (1) heliospheric space weather forecasting and early warning, (2) the three-dimensional initiation and evolution of coronal mass ejections (CMEs) and their magnetic structures, and (3) the acceleration and interplanetary transport of solar energetic particles (SEPs). The candidate payload combines remote-sensing instruments (a photospheric vector magnetograph, a chromospheric Hα imaging spectrograph, a solar X-ray spectrometer, an EUV imager, a coronagraph, and a heliospheric imager) with in-situ sensors for magnetic fields, solar-wind plasma, energetic particles, and radiation dose, thereby capturing the full eruption chain from the photosphere into the inner heliosphere. Together with L1 and L5 missions, the Korea-led L4 mission will establish an unprecedented multi-point observation network, advancing the fundamental understanding of solar-heliospheric coupling and substantially enhancing space weather forecasting capability essential for future lunar and Mars exploration.

16:25 [II-1-4]

Investigation of Solar Wind-Magnetosphere Interactions with a Dedicated Space Science Exploration Mission

Kyung Sun Park[1], Ensang Lee[2], Jaeheung Park[3], Jaehong Park[4], Jong Kil Lee[1], Junchan Lee[5], Kwangsun Ryu[5], Kyoungwook Min[6], Seulmin Baek[3]

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In 1958, Explorer 1 became the first mission to explore Earth´s magnetosphere. It discovered the Van Allen belts, proving that space is not empty but a highly dynamic environment. In 1959, Thomas Gold suggested naming the region the 'magnetosphere'. As of 2026, it is still a primary research target for understanding how our planet interacts with the solar wind.
Recently, advanced satellites have been providing incredible data on magnetospheric physics. One of the great missions is the Magnetospheric Multiscale (MMS) satellite. Using four identical satellites to sweep through the magnetosphere, capturing 3D images of nanosecond-scale bursts of tiny energy and providing atomic-level resolution, including the reconnection of invisible magnetic fields. However, even with numerous exploration satellites provided/providing long-term observations and data, we still do not fully understand the overall structure of the magnetosphere, and understanding macroscopic changes remains challenging.
This is why Korean-led missions and explorations are so important. We will discuss the necessity of a Korean magnetosphere exploration mission now and outline the physical phenomena and the unsolved issues of the magnetosphere we hope to solve.

16:40 [II-1-5]

Conceptual Design of Low-Energy Electrostatic Analyzer (LEEA) and Heavy-Ion Composition Analyzer (HICA) for Future Korean Deep-Space Missions

Jaeheung Park[1,2], Seul-Min Baek[1], Woo-Hyeong Seol[1], Junhyun Lee[1], Jongdae Sohn[1], Tae-Yong Yang[1], Jungjoon Seough[1], Kwangsun Ryu[3], Kyoung Wook Min[3]

[1]*Korea Astronomy and Space Science Institute (KASI)*
[2]*University of Science and Technology (UST)*
[3]*Korea Advanced Institute of Science and Technology (KAIST)*

Detecting low-energy (<100 keV) charged particles and discriminating their energy, mass, and degree of ionization are indispensable elements of contemporary deep-space exploration. In general, two instruments are combined to constrain these three parameters: an Electro-Static Analyzer (ESA) and a Time-Of-Flight-versus-Energy (TOFxE) instrument. The former measures the particle energy per unit charge, while the latter simultaneously determines the particle's charge and mass. In this presentation, we introducce a conceptual design of an ESA and a TOFxE instrument that can be carried on future Korean deep-space missions. The ESA has heritage from the Science and Technology Satellite-1 (STSAT-1), developed at KAIST in 2003; however, extensive upgrade and redesign are required to meet modern space-grade electronics standards. In contrast, a space-grade TOFxE instrument has never been developed in Korea. We discuss the merits and technological challenges associated with the domestic development of both instruments.

16:55 [II-1-6]

Middle Corona Linking from Sun to Heliosphere: Wide Field Solar EUV Imager

Sujin Kim, Jong-Yeop Park

Korea Astronomy and Space Science Institute

The middle corona, spanning 1.5 to 6 solar radii, represent a critical transition region where solar magnetic field expand into heliosphere. The physical transition in the middle corona imply that this place is a pivotal stage to determine how the heliosphere is structured by the solar energy (magnetic field and plasma) and how the space weather evolve. Despite its physical significance, this region still remains a missing link due to the field of view limitation of current EUV imager. Observing the middle corona in the EUV is highly advantageous as it capture magnetic structures in detail than visible-light coronagraphs. In this talk, we propose a Wide Field Solar EUV Imager designed to explore the physics in the middle corona provide a key insight into the space weather.

17:10 [II-1-7]

Conceptual Design of Korean Space Science Exploration Mission: Orbit, Payloads, and Satellite Development

Kwangsun Ryu[1], Kyungwook Min[1,2], Hyuchung Bang[3], Jinsung Lee[4], Dongheon Lee[3], Junchan Lee[1], Hanik Kim[1], Kyungsun Park[5], Jaeheung Park[6], Jaehong Park[7], Jongyeop Park[6], Seulmin Baek[6], Jaeheung Han[1,3], Daehyun Hwang[8], Woong-Rae Rho[9]

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We present the conceptual design of the Korean Space Science Exploration Mission, a 350–400 kg- class spacecraft launched by the Next-Generation Korea Space Launch Vehicle into a highly elliptical cislunar orbit. Using a 10–15-day resonance orbit (apogee >40 RE), the mission enables extended deep magnetotail observations, followed by a transfer to the cislunar Lagrange point for solar-wind monitoring and technology demonstration. The payload suite comprises seven in-situ instruments—FMAG (Fluxgate Magnetometer), SMAG (Search-coil Magnetometer), LEEA (Low Energy Electrostatic Analyzer), SWFC (Solar Wind Faraday Cup), HICA (Heavy Ion Composition Analyzer), MEPD (Medium Energy Particle Detector) / HEPD (High Energy Particle Detector)—and two remote sensing instruments – MEFA (Magnetospheric Electric Field Antenna) and EUSI (Extreme Ultraviolet Spectroscopic Imager) for the solar imaging. The spacecraft bus draws on NextSat and ADRSat heritage, with three-axis stabilization, bipropellant propulsion, and S-/X-band DSN communications. Key technology demonstrations include trans-lunar injection verification, VLBI-based navigation, and long-duration autonomous operations targeting launch in the early 2030s.

릴리 I

II-2 행성탐사 대기진입 임무개발

Chair: 최기혁(항우연)

15:40 [II-2-1]

Sensitivity of Martian Atmospheric Conditions to Dust and Solar EUV Activity along Mars Entry Trajectories Using the Mars Climate Database Model

Jeong-Heon Kim[1], Young-Sil Kwak[1,2], Jaewook Lee[1]

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

The Martian atmosphere exhibits significant variability driven primarily by atmospheric dust loading and solar extreme ultraviolet (EUV) radiation. These variations can strongly influence the atmospheric environment encountered during the entry, descent, and landing (EDL) phase of Mars missions. Understanding the sensitivity of atmospheric conditions to these factors is therefore essential for accurately characterizing entry environments and reducing uncertainties in mission design. In this study, atmospheric conditions along the entry trajectories of two recent Mars missions, Perseverance and InSight, are analyzed using the Mars Climate Database (MCD). The MCD provides global atmospheric fields derived from numerical simulations of the Martian atmosphere, including temperature, pressure, density, and dust distributions under various dust and solar EUV scenarios. Using reconstructed entry trajectories for both missions, vertical profiles of atmospheric density, temperature, and pressure are extracted along the descent paths. Sensitivity analyses are conducted using multiple MCD scenarios representing different dust loading conditions and solar EUV activity levels. The results show that atmospheric density and scale height along the entry trajectories vary depending on the dust and solar activity scenarios, with more pronounced differences in the lower and middle atmosphere. These findings highlight the importance of atmospheric variability when assessing the entry environments of Mars missions and demonstrate the usefulness of the Mars Climate Database (MCD) for mission analysis and atmospheric environment studies.

15:53 [II-2-2]

Light-Weight Ablative Thermal Protection Materials for Mars Entry

Seongwon Kim[1], Min-Soo Nam[1,2]

[1]*Cross-Functional Ceramics R&D Group, Korea Institute of Ceramic Engineering and Technology*
[2]*Department of Materials Science and Engineering, Korea University*

Thermal protection systems (TPS) are group of materials essential for protecting spacecraft from the aerodynamic heating experienced during entry into Mars atmosphere. Among candidate materials for TPS applications, carbon or ceramic ablative materials are ones for these applications.
In this study, we report the development of light-weight ablative thermal protection materials based on carbon or ceramic fiber. They are fabricated by using carbon or ceramic fiber and additives via typical ceramics processing. Some issues on processing difficulties are reported in order to produce properly fabricated of light-weight ablative thermal protection materials.

16:06 [II-2-3]

Overseas Development Status of Mars Atmosphere Entry Aeroshell and Analysis of 1D Trajectory and Aerodynamic Heating

Gi-Hyuk Choi, Dae-Young Kim, Jae-Ik Park, Jae-In Kim, Chun-Woo Lee

Korea Aerospace Research Institute

The Republic of Korea's 4th Basic Plan for Space Development Promotion stipulates the launch of a Mars lander in 2045. This requires the design and development of a Martian atmosphere entry aeroshell. The Martian atmosphere is primarily composed of carbon dioxide, with a density only 1/120 that of the Earth's atmosphere. This significantly reduces drag, lift and aerodynamic heating compared to the Earth's atmosphere, resulting in a nearly ballistic entry. The Perseverance aeroshell, with a diameter of 4.5 m and mass of 1,026 kg, begins its Martian entry at the altitude of 125 km with an entry angle of −16°. The aeroshell enters the atmosphere at the velocity of 5.4 km/s. After 80−100 seconds of entry, maximum aerodynamic heating occurs at the altitude of 40−50 km, generating the maximum temperature of 1,400℃ and the peak heat flux of 0.7 MW/m^2. In comparison, the Earth re-entry Stardust capsule, which weighs 45.8 kg and has the diameter of 0.8 m, begins re-entry at the altitude of 125 km with the entry angle of −8.21° and the speed of 12.6 km/s. The maximum heat flux of 9.4 MW/m2 and the maximum temperature of 2,900℃ are generated at the altitude of 60−70 km. In order to develop the domestic Martian atmosphere entry aeroshell, overseas cases were investigated, and cases of Earth atmosphere re-entry capsules were also investigated. This research data can be used as comparative reference data for the development of Earth atmosphere entry capsules and Mars atmosphere entry aeroshells in the future. In addition, initial reference data were secured by analyzing the Martian atmosphere entry using a one-dimensional analysis. This year, we plan to design a Martian entry aeroshell using the Non-Viscous Panel Method to derive a two-dimensional, three-degree-of-freedom (3 DOF) optimal trajectory and streamline analysis to analyze aerodynamic heating. In the future, we plan to use a supercomputer to fully compute the entire Martian

entry process using 3D Full CFD to analyze the six-degree-of-freedom (DOF) optimal trajectory, including attitude control, and aerodynamic heating.

16:19 [II-2-4]

Development of an Integrated Verification Framework for Mars Atmospheric Entry-Descent-Landing

Jae-ik Park, Dae Yeong Kim, Gi-Hyuk Choi, Jae In Kim, Seung-ryeol Oh, Jung-Ju Bae, Min Ki Kim, Jeong Heum Im, Choon Woo Lee

Korea Aerospace Research Institute

Mars atmospheric Entry–Descent–Landing (EDL) involves highly nonlinear flight regimes including hypersonic entry, supersonic deceleration, and terminal powered descent. Accurate prediction and control of these phases require simultaneous consideration of atmospheric density uncertainties, aerodynamic coefficient variations, and accumulated guidance–navigation–control (GNC) errors. Establishing a systematic design, analysis, and verification framework across the entire EDL sequence is therefore essential for future indigenous Mars landing missions.

This study is conducted as part of the 2025 Space Challenge Program of the Korea AeroSpace Administration (KASA) and aims to develop core technologies for Mars atmospheric EDL. The project is currently in the second year of Phase 1 and is carried out under a consortium led by the Korea Aerospace Research Institute (KARI), with participation from the Korea Institute of Ceramic Engineering and Technology (KICET), DACC Carbon, and Yonsei University. KICET performs thermal protection system (TPS) material characterization and thermo-structural evaluation under Mars entry conditions. DACC Carbon is responsible for TPS material fabrication and prototyping. Yonsei University develops guidance, navigation, and control (GNC) technologies for the entry and descent phases, including parachute-based deceleration.

KARI defines the overall EDL system architecture and develops a Python-based high-fidelity integrated verification framework for full-phase performance evaluation. The framework supports closed-loop 3-degree-of-freedom (3-DoF) and 6-degree-of-freedom (6-DoF) simulations covering entry, parachute-assisted descent, and powered landing phases. Sensitivity analysis and Monte Carlo-based dispersion evaluation are implemented to account for atmospheric and aerodynamic uncertainties, enabling progressive validation from algorithm-level performance to system-level behavior.

This presentation focuses on the design concept, system architecture, and implementation approach of the integrated verification framework for Mars atmospheric EDL.

16:32 [II-2-5]

A Study on Robust Localization for Terrain Relative Navigation on Mars

Jae-In Kim

Korea Aerospace Research Institute

Terrain-relative navigation (TRN) is essential for achieving pinpoint landing of a Mars lander during the entry, descent, and landing (EDL) sequence. This technology provides accurate position and attitude information to the descending lander, allowing it to perform appropriate maneuvers and thereby reach the designated landing point. TRN operates from heat shield separation during parachute descent to the early phase of powered descent. At the beginning of TRN, the lander has a very large position error. Therefore, TRN proceeds through two stages following a coarse-to-fine strategy. The first stage performs robust estimation to significantly reduce the initial position errors, while the second stage performs precision estimation to achieve higher positioning accuracy. In this study, as part of an effort to secure an indigenous Mars terrain relative navigation capability, a robust estimation algorithm is implemented and evaluated. In the proposed method, a frequency-domain matching technique was used to extract landmark correspondences, and three estimation models were defined to determine the lander position. Experimental data for performance evaluation were synthetically generated using high-resolution Martian topographic data. The experimental results demonstrated that the proposed method satisfied the performance requirements of the robust estimation stage.

16:45 [II-2-6]

Design Criteria and TPM Characteristics of Mars Entry Capsules

Dae Yeong Kim, Gi-Hyuk Choi, Jae-ik Park, Jae In Kim, Seung-ryeol Oh, Jung-Ju Bae

Korea Aerospace Research Institute

Since the Viking missions in 1976 through Tianwen-1 in 2021, various capsules have undertaken the challenge of Mars atmospheric entry. Achieving stable entry requires precise aeroshell design and a robust Thermal Protection System (TPS). To this end, this paper evaluates the geometries and design criteria of Mars entry capsules developed to date, while providing a comparative analysis of the characteristics of TPS materials

16:58 [II-2-7]

Development of Aerothermodynamic Characteristics and Trajectory Analysis Program for Mars Atmospheric Entry Capsule Design

Hoonjung Yeo[1], Na Kyeong Kim[1], Jae Gang Kim[2], Kyu Hong Kim[1,3]

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[2]*Department of Aerospace System Engineering, Sejong University*
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The Entry, Descent, and Landing (EDL) phase of Mars exploration involves severe aerodynamic heating and complex CO_2-dominated hypersonic flows. As the capsule decelerates from Mach 20 to 5, utilizing high-fidelity Computational Fluid Dynamics (CFD) becomes computationally prohibitive for preliminary shape design across broad flight regimes.
Therefore, this study develops a rapid, integrated trajectory and aerothermodynamic analysis program based on low-fidelity engineering methods. To achieve this, an existing Earth-entry trajectory tool is extended to predict Mars capsule flights by incorporating the Mars Climate Database (MCD) to accurately simulate Martian gravity and altitude-dependent atmospheric properties.
Furthermore, the aerodynamic heating prediction program MINIVER is modified to replace air-based models with CO_2-specific gas properties, convective heat transfer correlations, and thermochemical equilibrium effects in the post-shock layer. Finally, the reliability of this engineering analysis technique is secured by validating the computed surface heat loads and aerodynamic characteristics against hypersonic wind tunnel test data and flight data from previous Mars missions.

17:11 [II-2-8]

Analysis of Mars Arrival Conditions for Solar Sail Spacecraft Considering Entry Interface Constraints

Jung-Ju Bae, Jae-ik Park, Dae Yeong Kim, Gi-Hyuk Choi, Jae In Kim, Seung-ryeol Oh, Min Ki Kim, Jeong Heum Im, Choon Woo Lee

Korea Aerospace Research Institute

The arrival phase is a critical stage in Mars exploration missions, as spacecraft trajectories must satisfy dynamical constraints imposed by the Martian gravitational field and atmospheric environment. In particular, the arrival velocity and periapsis altitude strongly influence the feasibility of trajectory design and subsequent spacecraft operations near Mars, and are closely related to the entry conditions required for Mars atmospheric entry.
For spacecraft that rely on continuous low-thrust propulsion, the arrival conditions become especially important because trajectory control is achieved through gradual thrusting rather than impulsive maneuvers. Solar sails represent one such propulsion system that utilizes solar radiation pressure to generate continuous thrust without onboard propellant.
In this study, the arrival conditions of solar sail spacecraft at Mars are analyzed to investigate feasible trajectories under the constraints of the Martian environment. A Mars-centered dynamical model is developed incorporating solar radiation pressure and atmospheric drag effects. Numerical simulations are conducted to examine trajectory behavior under varying arrival conditions characterized by hyperbolic excess velocity and periapsis altitude.
In particular, the trajectory characteristics are evaluated in relation to the Entry Interface conditions for Mars atmospheric entry, including the velocity and flight-path angle at the entry interface. The analysis identifies feasible arrival regions that enable stable spacecraft motion after Mars arrival while satisfying the conditions required for Mars atmospheric entry. The results provide insight into the dynamics of solar sail spacecraft during Mars approach and offer guidance for trajectory design in future Mars exploration missions employing solar sail propulsion.

17:24 [II-2-9]

Integrated Simulation Framework for Atmospheric Entry and Vehicle Motion Analysis

Yuju Nam, Sang Lee

Korea Advanced Institute of Science and Technology

Since December 2025, a joint project on Mars atmospheric entry has been conducted by the Korea Aerospace Research Institute (KARI) and two partner organizations. The objective of the project is to establish an integrated system that combines domestic tools for atmospheric entry analysis, trajectory design, and ablation analysis. This effort is expected to improve the understanding of Mars entry conditions and to support mission design, capsule design, and thermal protection material studies. It may also contribute to future applications in Korean industry and education through the use of domestically developed technologies.
In this context, the presentation addresses technical topics related to atmospheric entry simulation. A brief review is given of the ALE (Arbitrary Lagrangian–Eulerian)-based non-inertial frame approach for moving-body analysis, together with an introduction to an existing CFD technique for handling moving-grid velocity.

사파이어 I

II-3 우주임무 및 시스템

Chair: 문봉곤(천문연)

15:40 [II-3-1]

A Qualitative Study on the Functional Requirements for Development of Lunar Communication Relay Orbiter

Jae-Hoon Song, Sang-Man Moon, Inkyu Kim

Korea Aerospace Research Institute

In November 2025, Korean government announced a plan to develop a lunar communication relay orbiter. In this paper, we first examine purpose and benefit of the proposed system in accordance with the Korea's master plan for space development. In addition, we review the basic concept of operations prior to start of development process and qualitatively present functional requirements from the perspective of system development to implement it.

15:55 [II-3-2]

Analytical Study of Self-Flipping Conditions for Two-Wheeled Rover

Junseok Lee[1], Taeyoung Lee[1,2], Namsuk Cho[1]

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[2]*Industry 4.0 Center, College of Engineering, Hanyang University*

Planetary exploration rovers must achieve both high mobility and stability under constraints of limited mass and simple mechanical structures. Two wheeled rovers are particularly attractive because their simple configuration allows lightweight design and agile maneuverability. However, the reduced number of wheels also makes them more vulnerable to overturning when operating on irregular terrain or near obstacles. In certain situations, overturning can be utilized as an active posture control strategy rather than being treated solely as a failure. By applying wheel torque, a rover can perform a self flipping motion that enables rapid reorientation or escape from unfavorable terrain conditions. This study derives an analytical condition under which a two wheeled rover can perform a self flipping maneuver that rotates the body by 180 degrees from a stationary state using wheel torque. The rover is modeled as a simplified rigid body system, and the onset condition for flipping is obtained by considering wheel radius, motor torque, center of mass location, and wheel ground friction. The analysis shows that the feasibility of self flipping depends not only on the magnitude of motor torque but also strongly on the geometric position of the center of mass and the friction characteristics of the ground. The proposed overturning condition provides a design criterion that can be used to evaluate the feasibility of self flipping and to analyze the influence of key design parameters during the design phase of two wheeled rover systems.

16:10 [II-3-3]

Indoor Test Facility for Lunar Surface Localization of a Lunar Surface Vehicle

Sangman Moon[1], Inkyu Kim[1], Jaehoon Song[1], Kyung-Soo Ha[2], Dong-Hee Kang[2], Dong-Chan Kim[2], Jong-Myung Woo[2]

[1]*Korea Aerospace Research Institute*

[2]*Chungnam National University*

This paper describes the construction of an indoor verification facility to validate localization technology for determining the position of a lunar surface vehicle. Lunar surface localization involves identifying the location of a communication radio source on a vehicle, such as a rover, exploring the lunar surface. The movement of the communication radio source through localization is controlled by a precision, automated rail within the indoor verification facility. The indoor facility supports the direction and distance of the radio source at a specified distance, assuming the vehicle moves along this rail. This allows for precise movement settings, minimizing moving errors accumulated due to experimental setting errors. If future, measurements are performed using the indoor verification facility in a consistent environment, even with variations in array configurations and array antenna elements, this will enable precise measurements of the direction and distance measurement algorithms for array antennas deployed on the lunar surface.

16:25 [II-3-4]

Design of a Radio Wave Source CubeSat for the Lunar Exploration Relay Satellite

Kyung-Soo Ha[1], Moon-Gi Hong[1], Dong-Hee Kang[1], Dong-Chan Kim[1], Sangman Moon[2], Inkyu Kim[2], Jong-Myung Woo[1]

[1]*Chungnam National University (CNU)*

[2]*Korea Aerospace Research Institute (KARI)*

Conventionally, communication and localization for lunar landers and rovers have been conducted via lunar orbiters. While this method has the advantage of securing a wide operational range for the rover from the lunar lander, it may be difficult to control the rover's position when the satellite is located in a shadow zone orbit, thus requiring multiple orbiters. Therefore, it is desirable to establish a communication network

with the lunar lander through Earth and lunar orbiters, and to detect and control the rover's position from the lander. To verify lunar communication relay, a radio wave source is required in the absence of a lunar lander. In this paper, we design and propose a CubeSat antenna with a UHF band isotropic pattern as a means of verifying the communication relay service by placing such a radio wave source in a communication relay orbit, and we confirmed that this CubeSat has an average antenna gain of over −4 dBi. In other words, we propose a concept of using a new isotropic antenna that does not require attitude control by utilizing the CubeSat body itself as a radio source for verifying the lunar orbiter relay performance.

16:40 [II-3-5]

Preliminary Stability Analysis of Coupled Motions of an Asteroid Probe Using the Rigid-Body Potential

Jinah Lee[1], Jay McMahon[2], Daniel Scheeres[2], Chandeok Park[1]

[1]*Department of Astronomy, Yonsei University*
[2]*Department of Aerospace Engineering Sciences, University of Colorado Boulder*

This study presents a preliminary analysis of the dynamical stability of the orbit-attitude coupled motions of an asteroid probe based on the rigid-body potential. The rigid-body potential is a unified potential for both orbit and attitude motions and can be used to investigate the gravitational interaction between the orbit and attitude motions of the asteroid probe. The asteroid is assumed to be spherical and to rotate uniformly about the axis normal to the orbital plane, and the principal axis frame is used for the probe system. Firstly, this study investigates the effects of the additional terms introduced by the rigid-body potential. The additional force due to the rigid-body potential is bounded, and it vanishes when the position direction of the probe is parallel to its intermediate axis and when the intermediate moment equals the mean of the elements of the inertia tensor. For stability analysis under an arbitrary attitude, this study classifies a total of three cases with respect to the inertia tensor and derives the equilibrium conditions for each case. Finally, we obtain and investigate the stability of each equilibrium state by linearizing and rearranging the equations of motion. If all elements of the inertia tensor are distinct, the in-plane motion is coupled with a single principal-axis angle. Additionally, it diverges because of the gravitational interaction. For instance, an initial deviation of 0.1080 m from the equilibrium state reaches a maximum of 81.2524 km after 200 days, and the mean distance is 5.9554 km. In future work, we will analyze the dynamics of a probe orbiting an asymmetric-shaped asteroid using the rigid-body potential.

16:55 [II-3-6]

Design Concepts and Key Requirements for Operation Display and Visualization Architecture of the Korea Pathfinder Lunar Lander Ground System

Dong-Gyu Kim

Korea Aerospace Research Institute

This paper presents design concepts and derives key requirements for the operation display and visualization architecture of the ground system for the Korea Pathfinder Lunar Lander (KPLL) mission, which commenced development in 2024, and is scheduled for launch in 2031. The derived concepts and requirements are intended to serve as the foundational basis for the full architecture design. The display and visualization functions addressed in this paper span three distinct operational phases: the launch and lunar orbit insertion phase, encompassing trajectory monitoring and spacecraft state visualization during translunar cruise; the powered descent and landing phase, providing real-time telemetry monitoring and three-dimensional trajectory visualization to support safe and precise touchdown; and approximately two weeks of lunar surface operations, encompassing science payload status monitoring and surface exploration activity visualization including rover traverse display. Drawing on a comprehensive survey of analogous international lunar lander and exploration missions, display design concepts are proposed and key requirements identified, with emphasis on structured information hierarchy for clear status awareness, intuitive schematic-based displays, mission-context-aware data filtering, and timely alert notification to reduce operator cognitive workload across all three mission phases. The proposed concepts and requirements provide a structured reference framework toward the PDR-level architecture definition.
Keywords: Korea Pathfinder Lunar Lander, KPLL, ground system, display and visualization, launch and orbit insertion, powered descent, lunar surface operations, payload monitoring, human-centered design, requirements

17:10 [II-3-7]

A Drone-Based Onboard AI Testbed for Space Mission

Hyun Jeong Choi, Jeong-In Yeo, Na-Yeong Hwang, Yong-Jae Moon

G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University

In deep space missions such as the Sun-Earth Lagrange Point 4 (L4) exploration, Deep Space Optical Communication (DSOC) technology is essential for high-capacity data transmission. however, verifying issues such as communication delay,

disruption, and Pointing, Acquisition, and Tracking (PAT) according to satellite movement in a ground environment is inherently limited. this study proposes an integrated testbed capable of simulating the space mission environment and verifying hybrid DSOC/RF systems and Delay-Tolerant Networking (DTN) protocols using drone platforms and onboard AI.
the testbed is established utilizing drones equipped with Jetson-based onboard AI modules. specifically, the autonomous flight function of the drones will be used to precisely simulate satellite movement patterns, including an orbital speed of 1.5°/s and variations in inter-satellite distances. furthermore, DTN-specific protocols such as BP (Bundle Protocol), CGR (Contact Graph Routing), and USLP will be implemented to analyze data integrity under communication delay and loss conditions. In addition, by providing a collaborative testing environment via a remote access gateway, this study is expected to contribute to enhancing the reliability of communication system for future space missions.

17:25 [II-3-8]

LEOP Results and Analysis of CAS500-3 (Compact Advanced Satellite) After Launch

Junho Lee, Juhwang Kim, Tae Seog Kim, Eui Hyun Lim, Jong-Jin Jang

Korea Aerospace Industry

This study presents the Launch and Early Orbit Phase (LEOP) results of Compact Advanced Satellite-3 (CAS500-3), a scientific mission satellite developed under the leadership of private industry. CAS500-3 is designed to perform three scientific missions through its onboard payloads. The first payload, the Republic of Korea Imaging Test System (ROKITS), monitors space weather phenomena, including solar wind and geomagnetic variations, through observations of Earth's aurora and airglow. The second payload, the Ionospheric Anomaly Monitoring by Magnetometer and Plasma-probe (IAMMAP), observes ionospheric disturbances using in-situ measurements of space plasma and magnetic fields. The third payload, BioCabinet, performs validation of three-dimensional stem cell differentiation and culture based on 3D bioprinting technology in a microgravity environment.
This paper describes the initial operational results of CAS500-3 during LEOP. The results demonstrate the reliability and applicability of the Compact Advanced Satellite platform. These findings are expected to serve as a reference for future satellite early operations and to contribute to sustained scientific mission execution and the expansion of various application services during the nominal operation phase.

릴리 II

II-4 안보우주 II

Chair: 김동환(육군)

15:40 [II-4-1]

A Study on the Response of the Army After the Fall of Space Objects Based on the Integrated Defense Concept

Jeong Hoon Yun, Oh Chang Kwon, Jaeho Bae, Deug Ki Lim, Han kyu Nam

Republic of Korea Army

With the New Space era, the number of artificial space objects has dramatically increased, and as a result, the risk of incidents such as falling space objects has significantly grown. In response to this, relevant agencies and the military forces have been treating such potential incidents as a disaster situation, primarily focusing on space situational awareness and disaster prevention. However, the potential for scenarios that threaten national security, such as the deliberate fall of space objects, cannot be excluded. Therefore, a response from a space security perspective is also necessary.
Therefore, to establish space security, the military forces must prepare detailed plans that cover not only space situational awareness and disaster prevention but also the post-incident response after space object fall incidents occur.
This study investigates measures for the army to conduct proactive response and recovery operations after artificial space objects fall, under the assumption of a security-threatening scenario.
Especially, this study focused on integrated response among the military, police, fire services, government and other relevant agencies by applying the Integrated Defense concept, which is applicable in situations of invasion and provocation.

15:55 [II-4-2]

An Iterative Hypothesis Verification-Based Multi-Agent Framework for Object Activity Inference in High-Resolution Satellite Imagery

Junesik Hwang, Daewon Jung, Minseok Park

University of Science and Technology (UST), KARI

High-resolution optical satellite imagery is a vital asset for national security, yet scene-level activity inference remains challenging due to confirmation bias, error propagation in linear pipelines, and the limitations of single-shot inference. To address these, this paper proposes an autonomous evolving multi-agent framework that redefines activity inference as an

iterative Hypothesis–Critic–Refinement process. The system employs three specialized agents: a Hypothesis Generation Agent for scenario production, a Rule-based Critic Agent for structural verification, and a VLM-based Context Critic Agent for semantic coherence. Central to this framework is the Experience Memory System (EMS), which utilizes a closed-loop intelligence to store and retrieve past analysis outcomes, allowing the model to avoid recurring errors and refine confidence scores through hybrid search.The framework was evaluated using 219 complex activity samples from the AI-Hub satellite imagery dataset across eight categories. Compared to a high-performance standard single-agent model, the proposed framework demonstrated superior reliability. Specifically, it significantly reduced the Expected Calibration Error (ECE) from 0.6119 to 0.2931, effectively suppressing the overconfidence typical of single-shot models. Additionally, a 16.4%p increase in Top-3 accuracy confirms that the iterative interaction between agents successfully maintains valid candidates that biased models might otherwise discard. This research concludes that transitioning to experience-based iterative verification is essential for providing calibrated, trustworthy intelligence for aerospace decision-making.

16:10 [II-4-3]

The Impact of Space Weather on Military CubeSatellite Orbital Operations and Operational Response Strategies

Oh-Chang Kwon[1,2,3], JaeHwan Lee[1], Hosub Song[3], Ki Hwan Keum[3], Jaejin Lee[3], Jongdae Sohn[3], Tae-Yong Yang[3], Youngbum Song[3], Jaeheung Park[3]

[1]*Republic of Korea Army*
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[3]*Korea Astronomy and Space Science Institute*

This study investigates the operational impacts of space weather on nanosatellites (under 100 kg) in Low Earth Orbit (LEO) and Very Low Earth Orbit (VLEO) research addresses the critical vulnerability of satellite constellations to atmospheric drag during geomagnetic storms.
The analysis applys the NRL-MSIS2.0 model to the SNIPE satellite's orbit to identify key operational variables for proactive orbit control. To address the hardware limitations of nanosatellites, prediction errors are evaluated by comparing North American Aerospace Defense Command (NORAD) Two-Line Element (TLE) data with Precise Orbit Determination (POD) data, using ESA's SWARM satellite measurements for cross-validation. Furthermore, The reliability of empirical models—including NRL-MSIS2.0, JB2008, and DTM2020—was tested against satellite accelerometer data during extreme solar events. These findings culminate in a proposed adaptive atmospheric model application strategy designed to ensure optimal orbit prediction across diverse military environments and volatile space weather conditions.

16:25 [II-4-4]

Characteristics Analysis of SAR Jamming and Interference Cases

Jaeho Bae[1,2], Jaemin Shin[1,3]

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[2]*Republic of Korea Army*
[3]*KOMPSAT-6 System Team, Korea Aerospace Research Institute (KARI)*

While Synthetic Aperture Radar (SAR) is a critical asset for all-weather surveillance, the influx of intentional jamming and unintentional interference has become frequent, particularly in global conflict zones and border areas. To develop effective anti-jamming technologies, it is essential to conduct a systematic analysis of the physical characteristics of jamming signals and the resulting image distortion patterns observed in actual satellite data.
In this study, various cases of SAR jamming and interference were collected from operational satellite imagery and analyzed in the image domain. Specifically, we examined the broad noise floor elevation in the range direction observed in international conflict zones such as Sevastopol, as well as the linear interference and artifacts appearing in the azimuth direction in the Korean border regions.
The characteristics derived from these cases will serve as fundamental data for precise signal-domain modeling, providing a crucial basis for improving the performance of jamming separation and suppression algorithms.

16:40 [II-4-5]

A Study on the Establishment of a Next-Generation Gravity Security Monitoring System Using Satellite Gravity Data: Focusing on the Achievements of the GRACE and GRACE-FO Missions

Donghwan Kim

Department of Civil Engineering, Korea Army Academy

This study proposes a framework for extending the application of GRACE (Gravity Recovery and Climate Experiment) and GRACE-FO (Follow-On) satellite data—which precisely track the changing pull of gravity—into the domains of national defense and space security. While conventional optical and synthetic aperture radar (SAR) satellite excel at monitoring surface facilities, they possess inherent limitations in detecting strategic assets hidden underground or invisible activities involving large-scale movements of mass below Earth's surface.

Drawing upon the capabilities of the GRACE Missions to measure the movement of mass within and between Earth's atmosphere, oceans, and land over the past two decades, this study presents three distinct security scenarios. First, the tracking of gravity anomalies resulting from mass redistribution, such as soil discharge and subsurface mass removal, during the construction of large-scale underground military facilities. Second, an analysis of the impact of geoid variations—caused by massive earthquakes and crustal movements—on the trajectory calculations of precision-guided munitions and inertial navigation systems. Third, the monitoring of resources security through observations of water resources and terrestrial mass change in border regions. Currently, the spatial resolution of GRACE data (approx. 300 km) is limited for detecting individual tactical sites. However, this study underscores that gravity information, by measuring mass regardless of whether it is visible or invisible, will serve as a critical component of Multi-INT (Multiple Intelligence) fusion in the future battlefield. Furthermore, it is expected that the establishment of a security monitoring network through gravity surveying will significantly contribute to the space security policy of the Korean Peninsula.

16:55 [II-4-6]

Machine Learning Ensemble-Based Automatic Classification of GNSS Interference Signals for Navigation Warfare (NAVWAR) Countermeasures

Jooyoung Kim[1,2]

[1]*Department of Future Air Mobility, Korea Aerospace University*
[2]*12th Infantry Division, Republic of Korea Army*

The growing sophistication of jamming, spoofing, and meaconing threats poses a critical challenge to GNSS-dependent military operations, particularly given North Korea's persistent GPS interference activities along the Korean Peninsula. Yet most existing studies focus on binary detection of a single interference type, leaving multi-class real-time classification largely unaddressed. This study proposes a machine learning ensemble framework—comparing SVM, Random Forest, XGBoost, and KNN—for automatic multi-class classification of GNSS interference signals using open-source real-world datasets (Jammertest 2024 and Yunnan University GNSS Dataset). Beyond classification performance, inference latency and feature importance analysis are evaluated as tactically relevant metrics. Findings are further contextualized within the Korean Positioning System (KPS) roadmap, offering actionable guidelines for AI-assisted PNT protection ahead of KPS full operational capability in 2035.

4월 23일(목) 그랜드볼룸 I

III-1 우주물리 II / 우주천문

Chair: 박재흥(천문연)

09:00 [III-1-1]

Global Simulation for Ancient Mars Interaction with the Solar Wind of the Young Sun

Kyung Sun Park[1], Kanako Seki[2], Jaeheung Park[3]

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

We have performed a global MHD simulation of ancient Mars. The simulation conditions as input parameters are a solar wind speed of 700 km/s, a number density of 300 /cc, and an IMF of 30 nT. The simulation box size is (nx, ny, nz) = (1100, 800, 800) with a grid spacing of 0.1 RM. The simulation results show new insights into early environmental conditions and the complex magnetospheric dynamics driven by a global magnetic field and a strong solar wind.

09:15 [III-1-2]

Multi-Point Geostationary Observation of Recent Major Space Weather Events

Daehyeon Oh, Eunjeong Cha

National Meteorological Satellite Center, Korea Meteorological Administration

Multi-point observations in geostationary (GEO) orbit provide critical insights into magnetospheric responses during extreme space weather events. This study analyzes major geomagnetic storms in November 2025 using data from GOES-18, GOES-19, GK2A, and Himawari-9. Simultaneous multi-point observations of the same space weather events confirmed distinct magnetospheric responses depending on satellite location. Some satellites experienced direct exposure to interplanetary space, showing sharp electron flux drops and Bz reversals, while others recorded gradual flux variations and delayed Bz changes, reflecting indirect magnetospheric effects. These observations demonstrate that spatial variations in magnetospheric dynamics can be directly captured in geostationary orbit.

09:30 [III-1-3]

Intense Gravity Waves Observed by AWE over the Korean Peninsula during an Sever Winter Storm over Japan in January 2024

Masaru Kogur[1], In-Sun Song[1], Hosik Kam[2]

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

Gravity waves (GWs) are generated by meteorological disturbances, propagate upward, transport momentum and energy, and drive the meridional circulation in the middle atmosphere. While many studies have emphasized GW generation by deep convection during warm seasons in lower and middle latitudes, cold-season convection at mid- and high latitudes has received less attention because convective available potential energy (CAPE) is typically low there. Recently, Kogure et al. (2024) demonstrated, using SD-WACCM-X/SAMI3 simulations, that convection within extratropical cyclones can generate concentric gravity waves that reach the thermosphere and ionosphere and drive the medium-scale traveling ionospheric disturbances (MSTIDs). In addition, Kogure et al. (2025) showed statistically that concentric MSTIDs accompanied by concentric stratospheric GWs are frequently observed in regions of high extratropical cyclone activity during winter.

This study investigates an intense mesospheric GW event over the Korean Peninsula on 24 January 2024, when a winter storm produced heavy snowfall in northwestern Japan. These GWs were observed by the Atmospheric Waves Experiment (AWE) aboard the International Space Station (ISS). Our ray-tracing analysis suggests that these mesospheric GWs likely originated over the Sea of Japan (East Sea), where Himawari-9 and Japan's meteorological radar network detected high cloud tops.

We will present the observation results together with a Weather Research and Forecast (WRF) simulations. The talk will discuss the potential relationship among the mesospheric GWs, the heavy snowfall, and the winter weather pattern associated with the Japan Sea Polar air mass Convergence Zone (JPCZ).

09:45 [III-1-4]

Introduction to Scientific Mission Concept for a 3.5-m Class Space Telescope

Sang Hyun Lee, Yong-Woo Kang, Jeong-Yeol Han, Bongkon Moon, Sungwook E. Hong, Donguk Song, Juhyung Kang, Chung-Uk Lee

Korea Astronomy and Space Science Institute

We present the scientific mission concept of a 3.5-m class segmented-mirror robotic space telescope designed for precision astrophysical observations and rapid-response capability in the near-ultraviolet to near-infrared wavelength range (0.2–3.0 μm). This space telescope adopts a Cassegrain optical configuration optimized to achieve diffraction-limited image quality across a wide and flat focal plane, targeting a Strehl ratio greater than 0.8 at 633 nm. The payload consists of three complementary scientific instruments. (1) A Wide-field Camera (WC) will perform multi-band imaging and high-cadence photometric monitoring over a field of view of approximately 10′–30′. (2) An Integral Field Spectrograph (IFS) will provide continuous spectroscopy across 0.2–3.0 μm with a spectral resolution of R = 100–300. (3) An Extrasolar Coronagraph (ESC) is designed to achieve high-contrast direct imaging with a raw contrast level of 10^{-9}. This space telescope is envisioned to operate either in Earth orbit or at the Sun-Earth L2 point. This mission architecture is structured around three core scientific pillars: (1) time-domain and multi-messenger astronomy, (2) stellar and planetary science, and (3) cosmology. These objectives enable a broad range of scientific investigations, including the characterization of gravitational-wave counterparts, rapidly evolving transients, Type Ia supernova cosmology, high-contrast direct imaging of exoplanets, and spectroscopic studies of exoplanet atmospheres. While driven by these key science goals, this space telescope is conceived as a versatile, general-purpose space observatory, providing open access to both domestic and international research communities. In this presentation, we discuss the scientific mission concept and its expected scientific impact.

릴리 I

III-2 행성과학 I

Chair: 이준현(천문연)

09:00 [III-2-1]

Conducting Layer in the Lunar Farside Mantle Inferred from KPLO Magnetometer

Wooin Jo[1], Ian Garrick-Bethell[2], Ho Jin[1], Shahab Fatemi[3], Andrew R. Poppe[4], Khan-Hyuk Kim[1], Hyeonhu Park[1]

[1] *Kyung Hee University*
[2] *University of California, Santa Cruz*
[3] *Umea University*
[4] *University of California, Berkeley*

The crystallization of the lunar magma ocean likely produced a chemically stratified mantle with high-iron, high-ilmenite, high-water late-stage cumulates at the top of the mantle. Subsequent mantle overturn may have caused these cumulates to sink to deeper parts of the lunar interior. Because electrical conductivity strongly depends on temperature and composition, electromagnetic (EM) sounding can provide insights into the Moon's interior by measuring magnetic fields induced in its conductive interior during rapid variations of the external magnetic field. Here we performed EM sounding using magnetic field measurements from the KPLO magnetometer (KMAG) acquired during the spacecraft's 100-km altitude phase over the northern lunar farside. This region is relatively primitive, being minimally affected by volcanic or impact-related processes, and

extends Apollo-era EM sounding observations that were limited to the nearside. To interpret the observations, we used the Amitis hybrid-kinetic plasma code to simulate the lunar EM response, including lunar wake effects, and to implement multi-layer conductivity models of the Moon. Background magnetic and plasma conditions from the THEMIS spacecraft, operating in highly elliptical lunar orbits, were used as simulation inputs. During a coronal mass ejection on 12 September 2024, a step-like ~20 nT change in the background magnetic field generated a clear induced response from the lunar interior. Comparison between KMAG observations and simulations suggests the conductivity of the upper lunar mantle is higher than that of the lower mantle, which is surprising since usually the increasing temperature with depth in plantetary bodies produces a continuous increase in conductivity with depth. We therefore propose minimal mantle overturn that left electrically conductive materials (e.g., iron-rich components, KREEP, ilmenite, and water) at relatively shallow depths.

09:15 [III-2-2]

Origin and Dynamics of Lunar Ions in the Magnetotail Lobes: Observations and Simulations

Khan-Hyuk Kim[1], Jaehee Lee[1], Yewon Hong[1], Dongseok Yun[1], Ho Jin[1], Seul-Min Baek[2]

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

Using Kaguya data spanning 1.5 years (January 2008–June 2009), we investigated the spatial distribution and dynamics of lunar-origin ions during intervals when the Moon was located within the terrestrial magnetotail lobes. These ions were detected in the energy range of 50–1,000 eV at altitudes of approximately 30–120 km on the dayside and consist mainly of heavy species such as C^+, O^+, Na^+, Al^+, K^+, and Ar^+. To investigate their origin and dynamics, we conducted test-particle simulations with cold ions (a few eV or less) generated at the lunar surface and in the exosphere. The results indicate that lunar-origin ions observed at spacecraft altitudes primarily originate from the Procellarum KREEP Terrane. The simulations further show that ions originating in the exosphere are more effectively energized than surface-generated ions. However, the ion energization obtained in simulations with typical lunar surface potential and lobe convection velocity is lower than that of lunar-origin ions observed at spacecraft altitudes, suggesting that additional acceleration mechanisms are required to explain the observations.

09:30 [III-2-3]

Investigation of the Magnetization Near Descartes Magnetic Anomaly

Hyeonhu Park[1], Ian Garrick-Bethell[2], Ho Jin[1]

[1]*Kyung Hee University*
[2]*University of California, Santa Cruz*

The Moon does not possess a global magnetic field today, but strong crustal magnetic anomalies provide evidence for an ancient lunar dynamo. The Descartes magnetic anomaly, located near the Apollo 16 landing site, exhibits isolated magnetic anomalies associated with high albedo markings known as lunar swirls. Here we investigate the magnetization of the Descartes anomaly using geologic relationships and magnetic modeling. We find topographic-albedo-magnetic field correlations that are especially pronounced just north of Descartes crater, and some high albedo deposits that appear to spill into this crater. Our interpretation is that these deposits are ejecta material from a large impact basin, the identity of which is currently unconstrained, with a thickness of order hundreds of meters. Based on the ejecta thickness, we can estimate the magnetic source volume. Multi-dipole source modeling indicates that the observed magnetic field at altitude requires crustal magnetization on the order of tens of A/m. Such strong magnetization implies that the lunar crust in this region was magnetized in the presence of a magnetic field with an intensity of at least several tens of μT, assuming the magnetized materials have a thermoremanent magnetic susceptibility similar to the most magnetic meteorites. Lower susceptibility values, e.g. those appropriate for indigenous lunar materials, give even higher ancient field strengths. These findings support recent work that shows the Moon had an ancient dynamo field of approximately Earth strength, for at least some portion of its history.

09:45 [III-2-4]

Statistical Study of Moon-Originating Ions in the Solar Wind

Jaehee Lee[1], Khan-Hyuk Kim[1], Yewon Hong[1], Seul-Min Baek[2], Ho Jin[1], Junhyun Lee[2]

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

When the Moon was in the solar wind, Kaguya frequently observed ions originating from the Moon. To examine their statistical properties, we analyzed Kaguya low-energy particle data obtained from January 2008 to June 2009. These Moon-originating ions were mainly detected on the lunar far side, with energies ranging from 20 to 300 eV. At the time of their creation at or near the lunar surface, the ions are expected to have energies of only a few eV or less. Consequently, the ions observed by Kaguya are energized by a factor of 10 to 100. Time-of-flight (TOF) analyses indicate that these ions consist of C^+, O^+, Na^+, Al^+, K^+, and Ar^+. We found a pronounced asymmetry between the Northern and Southern Hemispheres in the detection rate of Moon-originating ions. These ions are

concentrated mainly at high northern latitudes. To investigate the energization and asymmetric spatial distribution of Moon-originating ions, we perform test-particle simulations and discuss where and how the ions are energized and what produces the asymmetry.

10:00 [III-2-5]

Interaction between Solar Wind Particles and the Reiner Gamma Magnetic Anomaly: Observations and Test-Particle Simulations

Yewon Hong[1], Khan-Hyuk Kim[1], Jaehee Lee[1], Ho Jin[1], Seul-Min Baek[2]

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

Some lunar crustal magnetic anomalies are associated with albedo markings known as swirls; however, the processes governing their formation remain unclear. In this study, we focus on Reiner Gamma, a well-studied lunar anomaly and a key site for investigating the relationship between albedo patterns and magnetic anomalies. We perform test-particle simulations to examine how the Reiner Gamma swirl interacts with the local magnetic field, employing incident solar wind particles with energies of 0.5–1.0 keV and both line and disk magnetization models. The simulated magnetic fields are comparable to observations from previous lunar orbiters at altitudes of approximately 20 km and 40 km. Their maximum and minimum intensities, corresponding respectively to bright lobes and dark cusps on the lunar surface, align with the optical albedo patterns observed at Reiner Gamma. Our simulations show that the reflection area of solar wind particles above Reiner Gamma increases as the incident solar wind energy decreases. In the bright lobes, solar wind particle reflection exhibits a clear dependence on strong horizontal magnetic fields and dominant perpendicular energies. In contrast, reflection in the cusps is less definitive, being additionally governed by the interplay between relative perpendicular energy and magnetic configuration. We discuss the necessary conditions under which incident solar wind particles are absorbed at the surface or reflected above Reiner Gamma.

10:15 [III-2-6]

Spectral and Polarimetric Properties of Reduced Lunar Simulants with Grain Size and Metallic Iron Particles

Eunjin Cho[1], Seungju Han[2,3], Youngjae Kim[2], Serin Kim[1,3], Keewook Yi[4], Eunji Yi[1,3], Dongha Shin[5], Eunhee Kim[5], Mingyeong Lee[1], Chae Kyung Sim[1,3], Minsup Jeong[1]

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[4]*Korea Basic Science Institute (KBSI)*
[5]*Inha University*

Solar wind irradiation and micrometeorite bombardment produce metallic iron particles in lunar regolith. Impact events at various scales modify grain size through comminution. Because both grain size distribution and metallic iron affect optical properties, separating their individual contributions remains challenging. In this study, to examine these influence on optical properties of lunar simulants, we sieved JSC-1A and KLS-1 into two bulk fractions (<250 μm and <150 μm) and three size-separated fractions (90–150 μm, 45–90 μm, and <45 μm). Reflectance spectra and maximum degree of linear polarization (DoP) of the sieved samples were measured before and after hydrogen reduction, which forms metallic iron on grain surfaces. Reflectance increases with decreasing grain size but decreases after reduction, while positive DoP shows the opposite trend to reflectance, consistent with Umov's law. After reduction, smaller grains darken more, reducing reflectance contrasts among grain sizes; however, the polarimetric parameter *b*, derived from maximum DoP and reflectance, remains strongly grain-size dependent. Bulk fractions show intermediate reflectance but *b* values comparable to the finest grains. Future work will compare these results with natural lunar soils containing agglutinates to understand the respective roles of space-weathered rims and agglutinates in controlling lunar regolith optical properties.

사파이어 I

III-3 우주산업 · 인프라 / 우주응용 · 활용
Chair: 박원기(천문연)

09:00 [III-3-1]

Space Situational Awareness Sharing through SpaceTube

Peter JH Ryu[1,2,3], Shawn SH Choi[1,2,3], Henry H Hur[1], Franklin DI Kang[1], Alan SG Lee[1], Ethan SH Roh[1], Daniel MU Cho[1], Chase SG Hong[1], Douglas DS Kim[1,2,3]

[1]*SpaceMap Inc.*
[2]*Voronoi Diagram Research Center*
[3]*Hanyang University*

The rapid proliferation of satellite constellations and space debris has significantly increased operational coupling among

independent operators. When critical events occur, stakeholders currently lack platforms to share interpretable evidence. As highlighted by the 2021 close call between OneWeb and Starlink satellites—where operators had to coordinate evasive maneuvers primarily via email—relying on traditional communication methods is severely inefficient under time constraints. The central challenge in modern space situational awareness (SSA) and space domain awareness (SDA) is not merely computing event metrics, but communicating reproducible, inspectable, and decision-relevant event states quickly and accurately. To address this, we introduce SpaceTube, a novel platform for sharing SSA and SDA events via interactive 3D digital twins. SpaceTube facilitates real-time conferencing among invited participants by seamlessly integrating digital twin visualizations with video, audio, and text communication. The platform features an intuitive authoring tool, TUBifier, enabling users to easily create "tube clips" by defining a window-of-interest (WOI), objects-of-interest (OOIs, e.g., satellites and debris), and events-of-interest (EOIs, e.g., conjunctions and maneuvers) with just a few clicks. Furthermore, SpaceTube records these interactive sessions for asynchronous playback and future analysis. We envision SpaceTube as a vital communication hub for space industry professionals, providing an effective and efficient vehicle for sharing critical information and aligning perspectives in increasingly congested and contested orbital environments.

09:15 [III-3-2]

Onboard AI for Autonomous Observation Systems: Drone-Based Technology Demonstration for Event-Triggered Adaptive Sensing

Jeong-In Yeo[1], Hyun Jeong Choi[1],
Na-Yeong Hwang[1], Yong-Jae Moon[1,2]

[1] *G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2] *Department of Astronomy and Space Science, Kyung Hee University*

In this study, we investigate an onboard artificial intelligence (AI)-based autonomous sensing architecture to address the limited downlink bandwidth and communication latency in deep-space observation missions. We develop a perception-decision-action loop running entirely onboard and demonstrate its feasibility using a drone-based technology testbed. The system utilizes a lightweight vision pipeline on a NVIDIA Jetson Orin Nano to perform real-time object detection and target re-identification (ReID). Based on the inferred semantic information, the system autonomously adapts its sensing policies, directly generating control commands. The key findings of our study are as follows. First, our onboard AI successfully achieves near real-time target detection and continuous tracking with an end-to-end decision latency. Second, by employing an event-triggered region-of-interest (ROI) transmission strategy, the system significantly reduces the data communication load compared to conventional full-frame continuous transmission. Third, the system successfully executes adaptive sensing actions, such as motion-dependent observation frequency adjustment and waypoint revisit triggered by internal platform states (e.g., battery level and signal strength). Our results demonstrate that onboard AI-driven adaptive sensing policies can significantly improve mission efficiency. We expect that this autonomous architecture can be effectively applied to future deep-space observation platforms operating under severe communication constraints.

09:30 [III-3-3]

Lunar Terrain Relative Navigation: Integration of Vision-Based Methods

Hyunsung Kim, Sunwoo Mun, Seokju Lee

Korea Institute of Energy Technology

Terrain relative navigation (TRN) systems are essential for precise lunar landing in GPS-denied environments. However, standalone relative visual odometry suffers from inherent scale ambiguity and accumulated drift over extended durations, while map-referenced absolute localization remains highly sensitive to illumination changes and prior map uncertainties. To overcome these fundamental limitations, we propose an integrated TRN framework that dynamically fuses high-rate relative motion estimation from input image sequences with low-rate absolute localization based on the pre-built lunar crater catalog. An extended Kalman filter (EKF) is employed to continuously estimate the spacecraft's state, while constraining the metric scale and suppressing translational drift by leveraging absolute position fixes. Furthermore, we introduce a QuickMap-based lunar landing dataset targeting the lunar south pole, comprising four distinct illumination conditions with varying solar azimuth and incidence angles. Experimental evaluations demonstrate the feasibility of resolving scale ambiguity and improved localization stability compared to conventional frame-to-frame or map-only baselines, validating its real-time performance and suitability for vision-based autonomous landing in resource-constrained spacecraft systems.

09:45 [III-3-4]

Lunar Landing Site Evaluation: Self-Organizing Maps with Temporal Solar Visibility

Junseo Moon, Seokju Lee

Korea Institute of Energy Technology

We implement a lunar landing site evaluation pipeline based on a self-organizing map and extend the baseline formulation,

which uses mean solar visibility, by incorporating temporal solar visibility information. In the baseline formulation, solar visibility is represented by a time-averaged mean value, which does not capture the temporal structure of illumination and darkness intervals. Following prior topography-based illumination studies, we use a digital elevation model to estimate terrain-induced horizon obstruction in selected local regions of the lunar south polar area and combine it with SPICE-based solar geometry to model solar visibility over one synodic month (approximately 29.5 days) at fixed time intervals. From the resulting binary visibility time series, we derive raster features including average sun visibility, the longest period with solar illumination, and the longest continuous period in total darkness. We then incorporate these features as additional inputs to the self-organizing map to generate updated suitability and ranking maps. We examine four local south polar regions, namely Haworth, Shackleton, Cabeus, and Shoemaker, selected with reference to previously proposed candidate landing areas in the literature. Comparisons between baseline and temporally extended analyses suggest that temporal solar descriptors may alter local suitability patterns when similar mean visibility corresponds to different darkness-duration profiles. Furthermore, scenario-specific hourly analysis reveals that static suitability does not guarantee persistent operational availability over a one-month illumination cycle, highlighting the importance of temporal illumination modeling for local-scale lunar landing site analysis.

10:00 [III-3-5]

Tests for Prototype of Dragsail Deorbiter for Active Debris Removal

Min-Ki Kim

Korea Aerospace Research Institute

Active space debris removal (ADR) is to remove existing space debris for maintaining space environment and sustaining space development. This paper presents tests for prototype of dragsail type disposable deorbiter used to burn space debris. Cleaner satellite carries multiple deobiters to their targets, so the performance and economical efficiency is higher than previous ADR scenarios. The result for tests of the dragsail in deorbiter show the issues and remaining problems for the dynamics of sail deployment. First, booms must be permanently made by such as laser weld for metal or composite structure. Second, boom blooming can suppressed by eight point compression. Third, boom guide structure are useful to enhance the system stiffness, even though it has som problems to deploy booms. Finally, scratches from stowing and deploying the boom must be overcame in further studies.

릴리 II

III-4 안보우주 III

Chair: 박병찬(육군)

09:00 [III-4-1]

GNSS Precise Point Positioning for the ROKN Cruise Training Ship

Byung-Kyu Choi[1], Dong-Hyo Sohn[1], Jong-Kyun Chung[1], Dong-Jin Han[2], Junseok Hong[1]

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

The Republic of Korea Navy (ROKN) ship conducted an overseas cruise training mission from September 5 to December 23, 2024. The Korea Astronomy and Space Science Institute (KASI) installed GNSS receiver and antenna on the ROKN ship and collected data during the this period. We adopt the GNSS PPP method to estimate precise position of the ROKN ship. This study aims to demonstrate the feasibility of GNSS PPP for the ROKN ship and provides a solution for achieving precise real-time positioning in kinematic environments.

09:15 [III-4-2]

International Trends in Multi-Layered Orbital Navigation (LEO-PNT) and the Application of Ultra-Precise Navigation in Ground Operations

Woo-seok Lee, In-chan Lee

Republic of Korea Army HQ

Modern warfare has evolved beyond the traditional physical domains of land, sea, and air into a multi-domain operations (MDO) environment integrating space, cyberspace, and the electromagnetic spectrum. The recent Russia-Ukraine War has demonstrated that the operational effectiveness of precision-guided munitions and drone-based systems constitutes a decisive factor in determining the outcome of conflict. The fundamental enabler that allows these unmanned and advanced assets to accurately track targets and autonomously execute missions is Positioning, Navigation, and Timing (PNT) information. As weapon systems become increasingly precise and autonomous, dependence on PNT within military operations inevitably grows at an exponential rate.

Meanwhile, in the era of New Space, outer space has transformed from a domain of surveillance and reconnaissance into a primary arena of strategic competition and military dominance. However, the Republic of Korea's precision weapon systems remain heavily reliant on the U.S. Global Positioning System (GPS). As evidenced by North Korea's persistent electronic

warfare activities, particularly jamming operations, such dependence on a single system may result in critical operational constraints and even the degradation of command and control networks. In the face of increasingly sophisticated electromagnetic threats, ensuring the full operational capability of unmanned and precision strike assets requires the provision of highly precise and resilient PNT information that surpasses the limitations of existing systems.
Securing a high-precision and highly resilient PNT infrastructure is therefore a critical national security imperative to guarantee the integrity of multi-domain operations and the survivability of advanced weapon systems. In this context, this study analyzes the strategic necessity of such capabilities through real-world cases of electromagnetic interference and examines recent global technological trends. Based on this analysis, it aims to derive the military and security implications of developing a multi-layered orbital PNT architecture as a future direction for national defense.

09:30 [III-4-3]

The Importance of Rear Area Operations in Conducting Space Operations

Kang-woo Kim[1], Ho-Sung Choi[2], Jun-hyun Park[1]

[1]*2nd Operational Command*
[2]*Korea army Headquarter*

Space operations are performed using satellites operating at altitudes exceeding 100 km to accomplish mission objectives. For this purpose, ground segments transmit commands to satellites and receive the required information. Such command and data reception systems represent a critical element in the execution
In other words, the center of space operations can be considered the rear area where assets for satellite utilization and space surveillance are positioned. Therefore, to conduct effective space operations, it is essential not only to ensure the operational capability of ground-based systems but also to secure the ability to protect these systems during wartime.
Accordingly, the mission of the Second Operational Command, responsible for conducting combined and joint rear area operations, has a considerable influence on the execution of space operations.
Therefore, this study aims to explain the importance of the Second Operational Command, which is responsible for rear area operations supporting space operations, and to present its operational concept

09:45 [III-4-4]

Quantitative Cost-Benefit Analysis of LEO Satellite Communication for Korean Army Operations: Lessons from the Ukraine War Applied to the Korean Peninsula

Seon Woong Kim

1st Battalion, 108th Brigade, 36th Infantry Division, Republic of Korea Army

The commercial launch of SpaceX Starlink in the Republic of Korea in December 2025 has made LEO satellite military utilization an immediate procurement decision for the Korean Army. This study provides a quantitative cost-benefit analysis of commercial LEO satellite communication for Korean Army drone and artillery coordination, using open-source empirical data from the Ukraine war as an operational benchmark. ITU-R link-budget calculations confirm year-round operational feasibility on the Korean Peninsula, with a residual link margin of 14.4 dB under monsoon conditions and a round-trip latency of 40–60 ms that satisfies real-time drone control requirements—criteria that the geostationary ANASIS-II system, with its 600–700 ms latency, cannot meet. Drawing on RUSI (2023) data from Ukrainian operations, Starlink-enabled drone coordination reduced sensor-to-shooter cycle time by 85%, from approximately 20 minutes to 3 minutes.
Cost comparison against Korean Army budget data demonstrates that deploying 5,000 LEO terminals—approximately one per platoon across active ground forces—would cost approximately KRW 13 billion annually, or 16% of ANASIS-II's KRW 80 billion operating expenditure, while delivering 30–45-fold jamming redundancy. Korea-specific risk factors, including data sovereignty concerns arising from the absence of a domestic gateway station and the precedent of adversarial terminal acquisition, are identified as bounded, manageable costs requiring KCMVP-certified encryption and terminal whitelist controls. Based on these findings, this paper proposes a three-phase policy roadmap: near-term commercial LEO terminal integration (0–2 years), a civil-military indigenous 24-satellite test constellation (3–7 years), and full communication sovereignty through a 30–50 satellite indigenous constellation (7–15 years) at an estimated investment of KRW 1.5–2.5 trillion.

10:00 [III-4-5]

Autonomous Survivability for Small-Sat Constellations: An Intelligent Diagnosis Platform Based on Time-Series Periodicity Learning

Heonsu Kim[1], Hyeokmoon Yu[1], Jinyoung Bae[1], Joonki Paik[2]

[1]*Republic of Korea Army*
[2]*Department of Visual & Intelligent Systems Lab, Graduate School of AI, Chung-Ang University*

Recent defense space strategies have shifted toward maximizing surveillance and communication capabilities through the operation of small-satellite constellations. In such systems, autonomous

control technologies—where satellites diagnose their own health and ensure survivability—are essential to manage the exponentially increasing volume of telemetry (TM) data with limited personnel. This study proposes an intelligent diagnosis platform architecture that learns the inherent periodicity of satellite operational data to detect subtle anomalies caused by external interference or mechanical failures at an early stage.
The platform utilizes Fast Fourier Transform (FFT) to extract the unique rhythm of each sensor from complex multivariate time-series data, automating the data preprocessing pipeline. The core algorithm employs an unsupervised learning-based Autoencoder to deeply learn normal periodic patterns, combined with Extreme Value Theory (EVT) to calculate dynamic thresholds that minimize false alarms. Experimental results using actual satellite TM data demonstrated a high recall of 95.3%, successfully capturing subtle pattern disruptions that were undetectable by conventional threshold-based methods. These findings suggest that the proposed platform can serve as a critical intelligent module for future defense space control systems, ensuring the autonomous survivability of multiple satellite assets.

10:15 [III-4-6]

A Review on Technical Trends of U.S. SDA's Proliferated Warfighter Space Architecture (PWSA) and Implications for the Development of ROK Military Satellite Systems

Jaewhan Lee[1], Oh-chang Kwon[1,2], Hosub Song[3], Jaejin Lee[3]

[1]*Republic of Korea Army*
[2]*Korea Astronomy and Space Institute Campus, University of Science and Technology - Korea*
[3]*Korea Astronomy and Space Institute*

This study analyzes the core technologies and operational concepts underlying the Proliferated Warfighter Space Architecture (PWSA)—the next-generation satellite constellation spearheaded by the U.S. Space Development Agency (SDA)—to propose strategic directions for advancing the Republic of Korea (ROK) Armed Forces' satellite capabilities. Comprising hundreds of small satellites in low Earth orbit (LEO), the PWSA functions as the critical backbone for Joint All-Domain Command and Control (JADC2), facilitating low-latency data transport and advanced detection and tracking of hypersonic threats. Specifically, this paper examines the technical specifications of individual PWSA layers (notably the Transport and Tracking layers), Optical Inter-Satellite Links (OISLs), and the SDA's open architecture-driven agile acquisition strategies. The findings suggest that the ROK military should emulate the PWSA's interoperability standards and scalable mass-production models in developing its sovereign military satellite network. Ultimately, this research provides a strategic baseline for formulating future capability development plans to secure ROK space assets.

그랜드볼룸 I

IV-1 태양 및 우주환경 I

Chair: 나고운(경희대)

10:40 [IV-1-1]

Pioneering Auroral Imaging in Korea: First Results of ROKITS and the Path Forward

Woo Kyoung Lee[1,2], Hyosub Kil[1,3], Chanhaeng Lee[1], Se-Heon Jeong[1], Serin Jeon[1,2], Larry J. Paxton[3], ROKITS Team[1]

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

The Republic of Korea Imaging Test System (ROKITS), launched on November 27, 2025, onboard the CAS500-3 satellite, represents a significant leap in South Korea's space-based space weather observation. Operating at an altitude of 600 km in a sun-synchronous orbit, ROKITS uses a 90° wide field-of-view to monitor aurora and airglow in visible wavelengths. This presentation shares the first in-orbit imagery captured during the Launch and Early Orbit Phase (LEOP), showcasing the instrument's capability to resolve intricate auroral structures across a 700 km swath.
Beyond these technical achievements, this talk delves into the candid realities of the development process. We discuss the critical challenges faced by the team, particularly the limitations in specialized workforce and the technical hurdles of building a new type of observation system under constrained resources. These experiences have yielded invaluable lessons on mission resilience and the necessity of a sustainable research ecosystem. The mission's success confirms that South Korea is ready to contribute to the global research community. However, to transition from a "test system" to a "standard-setter," there is an urgent need for new talent and collaborative efforts. We conclude with a call to action for the next generation of researchers and engineers to join this expanding field, ensuring the continuity and advancement of Korea's presence in space science.

11:10 [IV-1-2]

Interpretable Data-Driven Models for Solar Flare Forecasting by Deep Learning and Symbolic Regression

Youngjae Kim[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[3], Gwangson Choe[1], Jihyeon Son[4], Mingyu Jeon[1]

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[3]*KU Leuven, Belgium*
[4]*Korea Astronomy and Space Science Institute*

Solar flares are explosive coronal phenomena that significantly impact near-Earth space weather. Despite advancements in empirical and deep learning (DL) forecasting models, prediction remains challenging; empirical models often oversimplify the underlying physics, while DL approaches lack transparency. In this study, we present a novel, interpretable forecasting framework for major (≧M-class) flares by integrating DL with Symbolic Regression (SR) using time-series Active Region (AR) magnetic parameters. Our SR-derived models achieve a True Skill Statistic (TSS) of 0.50 ± 0.17 and a Heidke Skill Score (HSS) of 0.36 ± 0.04, performing comparably to DL baselines (TSS: 0.38–0.56; HSS: 0.30–0.54). Remarkably, our approach yields concise mathematical formulae, reducing parameter complexity by over four orders of magnitude compared to standard DL models. A representative formula identifies a non-linear gating mechanism: flare probability is primarily driven by the flux near the polarity inversion line (R-value), but only when the interaction between total and absolute current helicity exceeds a specific threshold.This model successfully identified significant major flares in ARs 12673 and 13664, events that were largely missed by NASA CCMC flare scoreboard models. Our findings suggest that the squared sum of large-scale current helicity acts as a physical regulator for flare onset. This methodology offers a robust pathway for discovering new physical relationships across astronomy and related disciplines by bridging the gap between predictive performance and physical interpretability.

11:25 [IV-1-3]

Validation of Global Ionospheric Maps over Oceanic Regions Using Altimeter-Derived TEC

Woong Jeon[1,2], Woo Kyoung Lee[1,3], Hyosub Kil[1,4], Yong-Jae Moon[5,6]

[1]*Korea Astronomy and Space Science Institute*
[2]*School of Space Research, Kyung Hee University*
[3]*University of Science and Technology*
[4]*Johns Hopkins University Applied Physics Laboratory*
[5]*Department of Astronomy and Space Science, Kyung Hee University*
[6]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*

Global Ionosphere Maps (GIMs) are essential tools for monitoring ionospheric variability and space weather. However, as pointed out in previous studies, their accuracy over oceanic regions remains a concern due to the sparse distribution of ground-based Global Navigation Satellite System (GNSS) receivers. In this study, we quantify the reliability of GIM-derived Vertical Total Electron Content (VTEC) over the oceans as a function of distance from the nearest GNSS station. Independent VTEC measurements from the Jason-3 satellite altimeter are used as a reference dataset. We perform a spatiotemporally collocated point-to-point comparison to calculate VTEC differences between the two datasets. The results show that 99.3% of the collocated observations occur within 3,000 km of a terrestrial GNSS station, indicating that most GIM-derived VTEC estimates over the oceans remain influenced by nearby ground observations. Within this distance range, GIMs yield a correlation coefficient (CC) greater than 0.97, a root-mean-square error (RMSE) of 5.0–5.5 TECU, a normalized RMSE (NRMSE) of 0.05–0.1, and a bias of 4.0–4.5 TECU. Consequently, these results indicate that current GIM products remain reliable over oceanic regions despite the absence of local GNSS receivers. Furthermore, this study provides quantitative benchmarks for future improvements in global ionospheric modeling.

11:40 [IV-1-4]

Assessing High-Latitude Electrodynamic Drivers in SD WACCM-X

Jiwoo Kim[1], In-Sun Song[1], Wonseok Lee[2,3], Ja Soon Shim[2,4], Nicholas M. Pedatella[5,6]

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[4]*Science and Technology Institute, Universities Space Research Association, Huntsville, USA*
[5]*NSF National Center for Atmospheric Research, High Altitude Observatory, Boulder, USA*
[6]*COSMIC Program Office, University Center for Atmospheric Research, Boulder, USA*

The ionosphere–thermosphere (IT) system is highly sensitive to external forcings from both above and below, leading to complex and nonlinear error growth in simulations and predictions. To isolate and quantify uncertainties associated with space-weather forcing, this study investigates the impact of high-latitude ionospheric convection drivers, which represent the effects of space weather in the IT system, using the Whole Atmosphere Community Climate Model with thermosphere–ionosphere eXtension (WACCM-X). We employ the specified-dynamics configuration of WACCM-X, in which the lower atmosphere is constrained by nudging toward MERRA-2 reanalysis data. In this study, we compare three high-latitude

convection drivers: two empirical drivers, Heelis and Weimer, and one assimilative method, AMGeO (Assimilative Mapping of Geospace Observations). To examine the ionospheric responses to different high-latitude electrodynamic drivers, we conduct case studies of three geomagnetic storm events with varying intensities: April 2010 (G2), March 2013 (G3), and November 2015 (G4). The simulated total electron content (TEC) and O/N_2 are evaluated against both ground-based and satellite-based observations.

This research was supported by the KASI under R&D programs (2026-1-850-02) and G-LAMP and NRF grant (RS-2024-00442483).

11:55 [IV-1-5]

Evaluation of Irregularity Detection in the Bottomside Ionosphere Using COSMIC Data

Hoang Nguyen[1,2], Young-sil Kwak[1,2], Hyosub Kil[1,3]

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

The bottomside ionosphere, typically located below the F-region peak height, plays an important role in ionospheric irregularity formation but is not fully observed by ground-based instruments with limited coverage globally. In this study, we evaluate the capability of COSMIC radio occultation total electron content (RO TEC) measurements to detect ionospheric irregularities in the bottomside ionosphere. COSMIC observations from both low and high solar activity periods during solar cycle 23 (2008–2012) are analyzed. The analysis is restricted to the 120–400 km altitude range to avoid contamination from sporadic E layers and to focus on the region near the F-region peak. Case studies of nighttime irregularities are presented and validated through comparison with COSMIC S4 scintillation index measurements and ionosonde observations. The preliminary results demonstrate that COSMIC RO TEC provides a reliable means of detecting bottomside ionospheric irregularities.

릴리 I

IV-2 행성과학 II / 우주생명과학

Chair: 이민경(천문연)

10:40 [IV-2-1]

Science Missions, Landing Site Geology, and Payloads of Lunar Landers: Implications for the Korean Lunar Lander program

Byeon-Gak Choi

Seoul National University

This study presents a geology- and mission-oriented comparative analysis of the science objectives, landing site characteristics, and payload capabilities of past lunar landers. We reviewed 40 lunar landing attempts (26 successful, 14 failed) from Luna 9, which achieved the first successful soft landing on February 3, 1966, to Blue Ghost M1, launched on June 5, 2025. The analysis emphasizes how geological context and surface properties have shaped scientific investigations and instrument deployment strategies, and conversely, how mission goals and design have influenced target selection. We also examined landing regions designated for planned future missions and geologically valuable sites proposed for potential investigation where comparable data were available.

Landing sites are characterized by surface morphology, lithology, estimated formation ages, and local-to-regional geological context. Representative compositional units at previous or proposed landing sites include dark mantle deposits, low- and high-Ti mare basalts, highland anorthosites, high-Mg suite, KREEP-rich regions, young volcanic regions, the South Pole-Aitken basin, and permanently shadowed regions. Geological features of the lunar surface observable through landing missions include sinuous, linear, and arcuate rilles, fractures/faults, wrinkle ridges, irregular mare patches, lunar domes, lunar swirls, impact breccia/ejecta, and regolith layers.

Scientific payloads can be categorized into imaging, environmental, geophysical, geochemical, and mineralogical instruments. Imaging instruments are exemplified by panoramic cameras, while environmental instruments include high- and low-energy detectors for solar wind and galactic cosmic rays. Geophysical instruments comprise seismic detectors from Apollo missions and ground-penetrating radar from Chang'e missions. Geochemical instruments predominantly feature Alpha Particle X-ray Spectrometers, with Laser-induced Breakdown Spectroscopy first implemented on Chandrayaan-3. Infrared spectrometers represent the primary instruments for mineral composition analysis. Based on this geology-driven assessment, we outline implications for the Korean Lunar Lander Program and propose a framework for selecting landing sites that maximize scientific return—particularly regarding surface composition, key geological features, and evolutionary history—while ensuring engineering feasibility and operational safety.

10:55 [IV-2-2]

Characteristics of Spacecraft Jitters and Mitigation Plan for ShadowCam Stereo Imaging of the Korea Pathfinder Lunar Orbiter

Eunhyeuk Kim[1], Madeleine Manheim[2], Aaron Boyd[2], Moon-Jin Jeon[1], Mark Robinson[2], Prasun Mahanti[2]

[1]*Korea Aerospace Research Institute (KARI)*
[2]*Intuitive Machines (IM)*

The jitters of spacecraft is an inevitable aspect for the orbiters, such as the Korea Pathfinder Lunar Orbiter (KPLO, a.k.a Danuri). The jitters might limit the operation of cameras which need stable attitude adjustment of spacecraft for fine resolution. The requirement of jitters of KPLO was derived from the characteristics of KPLO/LUTI (LUnar Terrain Imager), a primary camera of KPLO. LUTI is equipped with optics and detectors enabling 2.5 m/px resolution at 100 km altitude. The NASA-provided instrument on-board KPLO, ShadowCam however, is designed with (1) higher spatial resolution, 1.6m/px and (2) Time Delay Integration (TDI) sensors to collect more photons to look into the inside of Permanently Shadowed Regions (PSRs) of lunar polar regions. In addition ShadowCam has been operated to obtain stereo images to understand the slope structure inside PSRs since late 2023. In the process of deriving DEM (Digital Elevation Model) inside PSRs using the stereo pair images of ShadowCam KPLO team (KARI and IM) noticed the significant amount of jitters from spacecraft, and investigated the details as well as any possible operational mitigation strategy to minimize the effect from jitters for the final product. The characteristics of jitters including the measured magnitude and the operational plan for mitigation will be presented.

11:10 [IV-2-3]

Hazard Characterization of Permanently Shadowed Regions on Mons Mouton from Multi-Source Orbital Data

Seon-Hoon Kim[1,2], Seonho Lee[1,2], Daewon Chung[1,2]

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[2]*University of Science and Technology, UST*

The lunar south pole has emerged as a focal point for the next decade of exploration, with at least eight missions planned between 2026 and 2031 including NASA's Artemis III, China's Chang'e-7, JAXA/ISRO's LUPEX, and ESA's Argonaut. A primary driver is the presence of volatile deposits within permanently shadowed regions (PSRs), considered essential for in-situ resource utilization. Safe access to these volatiles demands pre-mission hazard characterization at meter scales, yet no automated, quantitative hazard map exists for any PSR interior. Existing assessments rely on manual interpretation that assigns qualitative geomorphic descriptions rather than pixel-level safety estimates, and cannot scale to the hundreds of PSRs requiring characterization. ShadowCam aboard KPLO/Danuri has enabled high-resolution imaging of PSR terrain, but turning these observations into probabilistic safety products remains an open challenge.

In this study, we combine three complementary orbital data sources to map hazards across the VIPER Primary Mission Area on the Mons Mouton plateau, one of the Artemis III candidate regions. ShadowCam imagery is used to detect craters within PSR interiors, while LRO Narrow Angle Camera imagery covers adjacent sunlit terrain. At high polar latitudes, the gridded elevation model is largely built from interpolated data, and its slope estimates carry substantial uncertainty at meter scales. To address this limitation, LOLA altimetric data are used independently of the elevation model to obtain direct geometric measurements of individual craters. Terrain slope analysis from topographic products still addresses hazards at larger scales, while image-based detections combined with the altimetric measurements capture smaller features that the elevation model cannot reliably resolve. A probabilistic framework accounts for uncertainties from both paths and produces a per-pixel hazard exceedance map consistent with Artemis crewed landing safety requirements. We present preliminary results and discuss how the measurements obtained through this approach may offer insight into whether craters in permanently shadowed environments evolve differently from those on sunlit terrain.

11:25 [IV-2-4]

Candidate Target Search for a Korean Asteroid Impactor Mission

Youngmin JeongAhn, Hee-Jae Lee, Myung-Jin Kim, Hong-Kyu Moon, Sunho Jin

Korea Astronomy and Space Science Institute

We present a preliminary study on the identification of near-Earth asteroid (NEA) targets for a potential Korean kinetic impactor mission in the 2030s. Candidate objects were surveyed based on orbital accessibility, mission geometry, and observational feasibility under realistic mission constraints.

Among the investigated targets, (524522) Zoozve emerges as a particularly compelling candidate. Zoozve is classified as a potentially hazardous asteroid (PHA), exhibits X-type spectral characteristics, and is known as a Venus quasi-satellite. Its close approach to Earth at ~16.8 lunar distances on 31 October 2034 provides a favorable opportunity for a near-Earth impact experiment with reduced mission complexity.

This study outlines the basic properties of candidate targets and highlights Zoozve as a representative case for further investigation. The results are intended to support early-stage mission concept development and future detailed analyses of trajectory design, impact conditions, and post-impact observation strategies.

11:40 [IV-2-5]

Gravito-Electroporation: A Drop-Tower-Based Platform for Gene Delivery under Variable Gravity toward Astropharmacy Applications

Younghoon Lee, Vu Huu Pham, Sangmin Park, Seokbeom Lee

Space LiinTech Inc.

Long-duration deep-space exploration missions highlight the growing importance of astropharmacy, defined as the in-space production of pharmaceuticals and biomolecules using biological systems. Realization of such capabilities requires efficient cellular genetic engineering technologies that remain functional under altered gravity environments. However, the influence of variable gravity on cellular gene delivery processes remains insufficiently understood.

In this study, we developed a gravito-electroporation platform that integrates a drop-tower-based variable gravity system with a multi-electrode electroporation device. The platform enables precise synchronization between electroporation pulse application and the hypergravity-microgravity phases generated during drop-tower operation, allowing systematic investigation of how transient gravity changes affect membrane permeability, gene uptake efficiency, and post-transfection cell viability. We hypothesize that electroporation-mediated gene delivery efficiency may increase under variable gravity conditions compared with normal gravity environments, based on the possibility that gravity-induced mechanical stimuli may influence cellular membrane properties and facilitate transient pore formation during electroporation.

This platform provides a new experimental framework for studying the interaction between gravity modulation and electrically mediated gene delivery mechanisms. The proposed approach aims to contribute to the development of improved non-viral gene delivery technologies and to provide foundational knowledge for synthetic biology–based astropharmacy, enabling biological production of pharmaceuticals and biomolecules during future space missions.

11:55 [IV-2-6]

Autonomous Protein Crystallization under Microgravity: In-Orbit Demonstration of the BEE-PC1 Platform on the ISS

Jinyang Chung[1], Vu Huu Pham[1], Sangchul Shin[2], Jungmin Yoon[1], Byungho Kim[1]

[1]*Space LiinTech Inc.*
[2]*KIST (Korea Institute of Science and Technology)*

Long-duration deep-space exploration missions Determination of protein three-dimensional structures is fundamental for understanding biological function and enabling structure-based drug design. Under terrestrial gravity, convection and sedimentation can disrupt concentration uniformity in protein solutions and reduce crystal quality, whereas microgravity provides diffusion-dominated conditions that can support improved crystal growth. In this study, we developed BEE-PC1 (Biomedical Extraterrestrial Enclosure – Protein Crystallization 1), an automated platform designed to perform protein crystallization experiments aboard the International Space Station (ISS). BEE-PC1 autonomously conducts crystallization experiments without crew intervention and incorporates an optical monitoring module that enables real-time, non-invasive observation of crystal growth. The system was launched to the ISS in August 2025, where crystallization experiments were conducted in orbit, and the experimental samples and hardware were successfully returned to Earth in February 2026.

For the in-orbit demonstration experiment, the deubiquitinating enzyme USP7 (ubiquitin-specific protease 7) was selected as the model protein. USP7 is an important regulator of the p53–MDM2/MDMX pathway and a recognized therapeutic target in cancer research. The results demonstrate the feasibility of autonomous protein crystallization under microgravity and highlight the potential of such platforms to support structural studies for drug discovery.

그랜드볼룸 I

Invited Talk II

Chair: 최기혁(항우연)

13:20 [IS-2]

Towards a New Paradigm in Supernova Cosmology

Young-Wook Lee

Yonsei University

Supernova (SN) cosmology is based on the key assumption that the luminosity standardization process of Type Ia SNe remains invariant with progenitor age. However, direct and extensive age measurements of SN host galaxies reveal a significant correlation between standardized SN magnitude and progenitor age, which is expected to introduce a serious bias with redshift in SN cosmology. This systematic bias is largely uncorrected by the commonly used mass-step correction, as progenitor age and host galaxy mass evolve very differently with redshift. After correcting for this age bias as a function of redshift, the SN dataset aligns more closely with the wowaCDM model recently suggested by the DESI BAO project from a combined analysis using only BAO and CMB data. When the three cosmological probes (SNe, BAO, and CMB) are combined, we find a significantly stronger (>9 σ) tension with the LCDM model than that reported in the DESI papers, suggesting a time-varying dark energy equation of state in a currently non-accelerating universe. Finally, we discuss how these findings motivate new strategies and directions for precision cosmology with SNe Ia in the LSST era and through a future Korean-led UV space telescope mission.

그랜드볼룸 I

V-1 태양 및 우주환경 II

Chair: 이종길(충북대)

14:00 [V-1-1]

The 19 January 2026 S4 Level Solar Proton Event: Was It Driven by an Exceptionally Intense Solar Eruption?

Ryun Young Kwon

Korea Astronomy and Space Science Institute

We present a comprehensive analysis of an exceptionally intense solar proton event (SPE) that occurred on 2026 January 18–19 and was classified as an S4-level solar radiation storm, with the ≥10 MeV proton flux exceeding 10^4 pfu. According to the NOAA Space Weather Prediction Center catalog compiled since 1976, this event is the most intense event observed since the early 2000s. In this paper, we examine the characteristics of this SPE, together with its associated flare, CME, and shock observed in the solar corona. To investigate the missing information not directly accessible from observations, i.e., how the CME and shock propagate and accelerate energetic particles through interplanetary space, we also analyze the associated geomagnetic storm (GS), ground-level enhancement (GLE), and Forbush decrease (FD), if any. The SPE was associated with a long-duration X-class flare at S11E20, followed by a fast, Earth-directed halo coronal mass ejection (CME) with an approximately constant speed of ∼2000 km s^{-1} in the solar corona. The CME drove a strong shock, observed in the form of an EUV wave, and propagated through interplanetary space along the Sun–Earth line, with an average transit speed of ∼ 1500 km s^{-1}. The shock reached Earth roughly 25 hours after the flare onset, producing a clear energetic storm particle enhancement. The SPE onset was delayed by about 2.5 hours with respect to the flare start time, nearly coinciding with the time of EUV wave passage at the Earth's magnetic footpoint. The proton flux reached its maximum at the time of a severe GS classified as G4, and an FD also began as observed by ground-based neutron monitors, whereas no ground-level enhancement (GLE) was detected. Associations of GSs, GLEs, and FDs with SPEs larger than S3 level reported since 1976 are discussed in order to infer the characteristics of shocks propagating from the corona through interplanetary space. We conclude that the three-dimensional (3D) distribution of the shock Mach number plays a decisive role in proton acceleration, and that the evolution of the SPE energy spectrum during Sun–Earth transit may determine whether an SPE develops into a severe event. This work was carried out by members at the Center for Heliophysics Research and the Center for Heliophysics Observations and Technology, KASI.

14:30 [V-1-2]

Comparative Analysis of Subsurface Flows Beneath Solar Active Regions 12738 and 12673 Using Time–Distance Helioseismology

Bogyeong Kim[1], Sung-Hong Park[2], Yu Yi[1]

[1]*Chungnam National University*

[2]*Korea Astronomy and Space Science Institute*

We compare subsurface plasma flows beneath NOAA Active Regions (AR) 12738 and 12673 using time-distance helioseismology. AR 12738 maintained a stable β-type magnetic configuration during its disk passage, whereas AR 12673 evolved into a more complex structure following new flux emergence. Subsurface flows are analyzed from the surface down to a depth of 13 Mm. In both regions, shallow layers (0–3 Mm) show converging flows toward the umbra and diverging flows around the penumbra, while deeper layers are dominated by diverging motions that weaken with depth. AR 12738 exhibits relatively simple flow patterns, whereas AR 12673 shows more complex structures associated with multiple flux tubes.

14:45 [V-1-3]

Comparison of the Old TIE-GCM 2.0 with the Latest Version Regarding High-Latitude ExB Drifts

Young-Bae Ham[1,2], Geonhwa Jee[1,2]

[1]*Korea Polar Research Institute*

[2]*University of Science and Technology*

NCAR (National Center for Atmospheric Research) Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIE-GCM) is a numerical model which is widely used in the space science community for thermosphere and ionosphere research. A new version of the model has been released 2 years ago, and it includes some new features and functional changes. We compared these two versions and found that they give completely different high-latitude ExB drifts. It raised questions because the high-latitude electric potential is solely dependent to the high-latitude ionospheric convection models and these two versions use the same ion convection models for the high-latitude inputs. A detailed analysis on this issue reveals that the Earth's magnetic fields, which are calculated by the IGRF coefficients, are responsible for the issue. The magnetic fields from the TIE-GCM 2.0 is completely incorrect for model runs after 2015. It results in underestimation of the high-latitude ExB drifts, and it seems that not only it has impacts on the high-latitude region but also has global impacts, resulting in changes in various physical parameters. It is also found that TIEGCM 2.0 model-run results from the NASA CCMC (Community Coordinated Modeling Center) are also exposed to this issue.

15:00 [V-1-4]

Impact of Geomagnetic Storm Intensity on Thermospheric Density Enhancement and Orbital Decay of LEO Satellites

Jeong-Heon Kim[1], Giwwong Eom[2], Young-Sil Kwak[1,3], Tae-Yong Yang[1], Hwanil Huh[2]

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

Geomagnetic storms significantly enhance thermospheric density, resulting in increased atmospheric drag on low Earth orbit (LEO) satellites and accelerated orbital decay. In this study, we analyze 20 geomagnetic storm events categorized by the NOAA geomagnetic storm scale (G1–G5) to investigate the relationship between storm intensity, thermospheric density enhancement, and satellite orbital decay rates. Orbital decay rates were derived from precise orbit data of the GRACE and GRACE-FO satellites, which provide high-accuracy measurements suitable for detecting thermospheric drag variations. For each event, thermospheric density variations and orbital decay rates (km/day) before and after storm onset were evaluated to quantify storm-time drag effects. The results show a clear dependence of orbital decay enhancement on storm intensity. Weak storms (G1) produce only minor increases in orbital decay (~3%), while moderate storms (G2–G3) lead to increases ranging from approximately 20% to over 160%. Strong storms (G4) produce increases up to ~220%, and extreme storms (G5) show enhancements approaching ~300% in orbital decay rate. These findings demonstrate a strong coupling between geomagnetic storm activity and thermospheric drag experienced by LEO satellites. The quantitative relationship identified in this study provides useful insight for improving satellite orbit prediction and understanding space weather impacts on the near-Earth space environment.

15:15 [V-1-5]

Empirical Formula of CME Travel Time by Symbolic Regression

Changeon Park, Youngjae Kim, Mingyu Jeon, Yong-Jae Moon

G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University

In this study, we derive an empirical formula for the travel time (TT) of coronal mass ejections (CMEs) using symbolic regression. For this we use a data set constructed by Napoletano et al. (2022), which consists of 216 interplanetary CME (ICME) events from 1997 to 2018 based on the Richardson and Cane ICME catalog and the coordinated data analysis workshop (CDAW) CME catalog. We also use 1-hour interval solar wind speed data provided by OMNI. As input parameters for the model, we use the CME speed and acceleration at 20 solar radii, the solar wind speed at Earth when the CME passes 20 solar radii, and the solar wind speeds at 26, 25, 24, and 23 days prior to that time. Our major results are as follows. First, the primary parameter selected by the model is the CME speed, which is the most important factor in predicting the TT, as already well known. Second, the next selected parameter is the solar wind speed 23 days prior, which corresponds to the background solar wind speed of previous solar rotation if its traveling time is assumed to be 4 days. This suggests that background solar wind speed is also important for the TT of CMEs and it can be approximated estimated as that of the previous solar rotation. We will examine additional parameters such as CME source location and corona hole properties to identify the main parameters controlling CME TT.

15:30 [V-1-6]

Butterfly Pitch Angle Distributions in LEO: Signatures of Electron Loss from the Inner Radiation Belt

Jaejin Lee, Jaehung Park, Hosub Song, Jongdae Sohn, Tae-Yong Yang

Korea Astronomy and Space Science Institute

Extreme geomagnetic storms drive profound and rapid changes in Earth's radiation belts, yet the mechanisms underlying fast electron loss and redistribution in the inner belt remain poorly understood. Although wave–particle interactions are commonly invoked, the modest amplitudes of observed waves have cast doubt on their capacity to induce strong pitch-angle diffusion. Here we report high-resolution pitch-angle observations from the SNIPE CubeSat mission during the extreme geomagnetic storm of early May 2024, revealing pronounced butterfly pitch-angle distributions (flux minima near 90°) of inner radiation belt electrons at low Earth orbit altitudes—a phenomenon rarely documented in this region. These distributions display three distinctive features: (1) strong energy dependence, with clear butterfly shapes below ~100 keV transitioning to pancake distributions above ~120 keV; (2) a partially filled loss cone coexisting with the butterfly structure, indicating exceptionally efficient pitch-angle scattering that maintains substantial flux in the atmospheric loss cone; and (3) a sharp flux drop precisely at the loss-cone boundary, visible only owing to the measurements' superior pitch-angle resolution. Test-particle simulations incorporating a pitch-angle redistribution approach demonstrate that scattering by modest-amplitude VLF waves—whose efficiency is markedly enhanced by storm-time reductions in background cold plasma density—quantitatively reproduces all observed characteristics. These findings reveal that wave–particle interactions assume a substantially more prominent role in inner radiation

belt dynamics during extreme space weather events than previously appreciated, highlighting the essential role of low-altitude, high-resolution pitch-angle observations in deciphering rapid radiation belt loss processes.

15:45 [V-1-7]
Revisiting Flare-CME-SEP Relations

Sung-Hong Park[1,2]

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

Solar flares, coronal mass ejections (CMEs) and solar energetic particles (SEPs) are major solar eruptive events that can significantly affect the near-Earth space environment. Despite extensive studies, the solar conditions that lead to SEP events observed at Earth are still not fully understood. In this study, we revisit flare-CME-SEP relations using a large dataset spanning 1997 to 2020. SEP events and their characteristics were identified using >10 MeV proton flux measurements from particle detectors onboard the Geostationary Operational Environmental Satellites (GOES). For each SEP event, solar activity during the 24 hours preceding the SEP onset was examined. Flare properties were derived from 1-minute cadence soft X-ray flux measurements from the GOES X-ray Sensor (XRS), and the locations of associated flares were determined when available. CME properties were obtained from observations by the Large Angle and Spectrometric Coronagraph (LASCO) C2 onboard the Solar and Heliospheric Observatory (SOHO). CMEs occurring within the same 24-hour interval prior to the SEP onset were analyzed in terms of angular width, position angle, speed and brightness. SEP events were classified according to their characteristics (including intensity, duration and the presence of multiple peaks), and the statistical properties of associated flares and CMEs were compared among the SEP subgroups. In addition, we examined cases in which flares or CMEs occurred without producing SEP events detected at Earth to better understand the conditions favorable for Earth-directed SEP events.

릴리 I

V-2 대한민국 우주과학탐사 계획과 사업 추진 현황
Chair: 김민재(우주청)

14:00 [V-2-1]
Lunar Communication Orbiter Development Strategy

Jaehong Park

Korea AeroSpace Administration

Major space agencies are planning crewed lunar bases and south pole missions. This is driving a strong need for orbital systems that can support high-capacity relay links and accurate navigation. Building on this trend, major countries are preparing in-orbit demonstrations of lunar communication and navigation orbiters in the late 2020s to take an early lead in this emerging market, while Korea has already achieved high technological maturity in key areas such as lunar orbiter design and manufacturing through the KPLO (Danuri) mission. Building on these capabilities, this presentation outlines a lunar communication orbiter mission to demonstrate lunar communication and navigation technologies, discusses how compatibility with the LunaNet architecture could enable global lunar communication and navigation services, and considers a public-private partnership approach in which industry leads business model development and government provides core infrastructure and initial demand.

14:15 [V-2-2]
Mars Exploration Base Technology Demonstration Initiative

Hak-Sub Kim, Hwasu Hyun

Korea AeroSpace Administration

The Space Science and Exploration Directorate of the Korea AeroSpace Administration (KASA) is currently developing a Mars Exploration Base Technology Demonstration Initiative based on the Space Science Exploration Roadmap and the Mars Exploration Strategy established last year.
In space exploration, securing space heritage through the demonstration of exploration technologies in the space environment is a critical factor for improving mission success rates. This initiative aims to strategically utilize international launch services for Mars missions to demonstrate domestically developed technologies directly on the Martian surface. Through this effort, we aim to secure key technologies for future Mars exploration and Mars base construction at an early stage, while strengthening the capabilities of domestic industries.
By conducting technology demonstrations prior to Korea's full-scale Mars exploration missions, this initiative is expected to reduce technical uncertainties and schedule risks, thereby improving overall mission success probability.
This presentation introduces the objectives, strategic framework, and expected outcomes of the proposed initiative.

14:30 [V-2-3]
Current Status of SKAO International Cooperation and Domestic Policy Trends

Jaebeom Kim

Korea AeroSpace Administration

This presentation introduces the latest international cooperation status of the Square Kilometre Array (SKA) and Republic of Korea's related policy trends. The SKA is a large-scale scientific project that explores the early state of the universe and dark energy by installing 144 radio telescopes in South Africa and about 78,000 antennas in Australia. Today, a solid international governance has been established, centered around the international organization SKAO. In early 2026, the success of 'First Fringes' by the SKA-Mid telescope in South Africa proved that the related infrastructure is fully functional. In this presentation, we will discuss strategic policies aimed at encouraging Korean industries and researchers to play a more active role in the global astronomy and space science community.

14:45 [V-2-4]

Small-Scale Unmanned Space Manufacturing Platform Demonstration

Jong-gyun Kang, Minjae G. Kim, Suhyeong Lee, Subin Baek, Jihun Kwon

Korea AeroSpace Administration

As global competition in space development intensifies, leading spacefaring nations are advancing experiments and demonstrations aimed at creating new industries in microgravity-based space manufacturing. In response, Korea has identified space manufacturing as a key mission in its Master Plan for Promotion of Space Development and is pursuing related projects and policies under the leadership of the Korea Aerospace Administration (KASA). This paper introduces the space manufacturing initiatives outlined in the Republic of Korea's Space Science Exploration Roadmap, publishsed by KASA. and presents the 'Small-Scale Unmanned Space Manufacturing Platform Demonstration' project, scheduled to commence in 2026, as a cornerstone effort to foster a new domestic market and build a sustainable ecosystem.

15:00 [V-2-5]

Toward Digital Engineering in Space Science Explorations

Suhyeong Lee, Subin Baek, Minjae Kim, Jonggyun Kang, Jihun Kwon

Korea AeroSpace Administration

Space science exploration missions are complex systems of systems, requiring efficient information management and reliable processes under limited resources. Traditional document-based engineering struggles to address these complexities, highlighting the need for digital engineering centered on model-based approaches. Model-Based Systems Engineering (MBSE) integrates requirements, design, and verification through digital models, ensuring consistency, reducing costs, and improving quality. This study emphasizes the necessity of MBSE in space exploration, drawing on international case studies to propose phased domestic implementation and expansion toward digital twins.

15:15 [V-2-6]

Lunar Surface Science and Technology Missions: Current Status and Future Plans

Jinhye Park

Lunar Lander Program, Space Science Exploration Directorate, KASA

Recent lunar exploration has increasingly focused on surface science to better understand the Moon's geological history, surface environment, and potential resources. In this context, Korea is preparing its first lunar soft-landing mission planned for 2032. The mission will conduct scientific investigations on the lunar surface with three primary objectives: (1) observation of the lunar dust and space environment, (2) analysis of the chemical composition of the lunar surface, and (3) investigation of lunar topography and geological features. These observations will provide important insights into the lunar surface environment and geological evolution, while also supporting future lunar exploration and long-term surface operations.

15:30 [V-2-7]

KASA's Plan for Lunar Surface Mobility and Infrastructure

Seungsoo Park, Sunhoon Kim, Jinhye Park, Minseong Kim, Ijeung Kim, Beomseok Lee, Dong Young Rew

Korea AeroSpace Administration

Based on a strategic roadmap for lunar exploration, KASA is advancing surface mobility and infrastructure initiatives. Under this framework, KASA is preparing a mobility development project targeted for the 2032 lunar lander. While domestic rovers remain in the ground model phase, future upgrades will target medium-sized platforms, swarm mobility, and long-distance traverse. Meanwhile, preliminary studies on lunar infrastructure are underway, including a Warm Electronic Box (WEB), solar-based power generation with wireless transmission, and resource extraction and storage. This presentation outlines the current technological readiness and future directions of these efforts.

15:45 [V-2-8]

Current Status and Future Perspectives: Lunar Lander Development of Republic of Korea

Minseong Kim, Sunhoon Kim, Beomseok Lee,

Seungsoo Park, Jinhye Park, Ijeung Kim, Dongyoung Rew

Korea AeroSpace Administration

As global interest in lunar exploration intensifies and commercialization activities accelerate, South Korea is actively striving to secure independent lunar exploration technologies through the “Lunar Exploration Phase 2 (Lunar Lander Development)” project, following the establishment of the Korea AeroSpace Administration (KASA). In alignment with existing policy frameworks and the “Space Science and Exploration Roadmap” unveiled in December 2025, KASA is planning various lunar missions to bolster national competitiveness, with the lunar lander identified as a critical component. This paper shares the current status of lunar lander development in South Korea and proposes strategic development approaches to prepare for future lunar exploration missions.

사파이어 I

V-3 우주광통신

Chair: 임형철(천문연)

14:00 [V-3-1]

Design of the Optical Communication Terminal for the Next-Generation LEO Satellite Constellation

Kwon-Seob Lim, Man-Seok Uhm, Dong-Pil Chang

Electronics and Telecommunications Research Institute

The era of global low Earth orbit (LEO) satellite communications has begun, led by SpaceX’s Starlink constellation, which adopts an optical communication–based mesh network architecture. In addition, Amazon in the United States and Telesat in Canada are also developing large scale LEO satellite constellations to establish their own global satellite communication networks. In these systems, reliable high capacity optical communication terminals are key enabling technologies for achieving high-throughput and low-latency data relay in space. To support inter-operability, standardization activities for optical communication terminals are being actively pursued by the Space Development Agency (SDA) and the European Space Agency (ESA) for both commercial and defense applications. In Korea, Electronics and Telecommunications Research Institute (ETRI) has been developing an optical communication terminal for next-generation LEO satellite constellations since April 2024. The terminal is designed to support a data rate of 10 Gbps and operates at the 1,550 nm wavelength band. Link budget analysis shows that reliable 10 Gbps optical inter-satellite communication is achievable over distances of several thousand kilometers. This paper presents the current design status of the optical communication terminal and outlines the development plan for the coming year.

This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No, RS-2024-00398409, Development of Optical Inter-Satellite Communication Technology for Next-Generation LEO Satellite Constellation).

14:15 [V-3-2]

Design and Development of a Ground-Based Optical Communication Terminal

Ki Pyoung Sung, Hyung-Chul Lim, Sung-Yeol Yu, Sang-won Park

Korea Astronomy and Space Science Institute

The rapid growth of the New Space sector, the expansion of space exploration missions, and the increasing demand for the transmission of high-resolution and high-volume satellite data have highlighted the limitations of conventional radio-frequency (RF) communication systems. In this context, laser communication has emerged as a promising next-generation communication technology owing to its capability for ultra-high-speed and high-capacity data transfer, enhanced security, reduced constraints from spectrum regulation, and favorable SWaP (size, weight, and power) characteristics.

This study presents the design and development of a ground-based optical communication terminal to address these technological demands. The proposed terminal consists of an optical telescope assembly (OTA), a gimbal mount for precision pointing, a control unit for system operation, and an optical bench integrating the core optical components. For the implementation of Pointing, Acquisition, and Tracking (PAT), the system employs a 633 nm wavelength for beacon transmission and a 785 nm wavelength for beacon reception. In addition, a 1,550 nm wavelength is adopted for communication transmission. Based on these wavelength configurations, the optical, mechanical, and control architectures of the terminal were systematically designed, and the integrated terminal was developed accordingly. This work describes the development of a ground-based optical communication terminal and suggests its potential applicability to future optical communication systems. It also provides a practical foundation for the advancement of laser communication technologies in next-generation space and terrestrial communication environments.

14:30 [V-3-3]

High-Performance Fine Steering Mirrors for Space Optical Communication Systems

Young Kwan Kwon, Ju Hahn Lee, Won Jun Lee,

Jae Young Jeong, Jung Cho, Byung Jik Lim
Incerasolution Co., Ltd

Space optical communication systems require highly accurate beam pointing and stabilization to maintain reliable optical links between satellites and ground stations. Fine Steering Mirrors (FSMs) are critical components of the pointing, acquisition, and tracking (PAT) subsystem, providing high-speed angular correction to compensate for platform disturbances and pointing errors. This study presents high-performance FSM technologies developed for space optical communication applications, focusing on two actuator configurations: a piezoelectric-driven FSM and a voice-coil-driven FSM. The piezoelectric FSM is designed to achieve high bandwidth and precise angular positioning within a compact structure, enabling rapid beam stabilization under high-frequency disturbance conditions. In contrast, the voice-coil-driven FSM provides relatively larger angular stroke and flexible dynamic characteristics, which are advantageous for systems requiring wider pointing ranges and effective disturbance rejection.

Both FSM systems incorporate lightweight mirror assemblies, high-stiffness mechanical structures, and closed-loop control architectures to achieve stable and precise beam steering performance. Key design considerations include actuator configuration, structural stiffness optimization, resonance characteristics, and control bandwidth. The performance of the developed systems has been evaluated in terms of angular stroke, linearity, repeatability, and resonant frequency to assess their suitability for precision optical pointing applications.

Environmental tests have been conducted to verify the mechanical integrity and functional stability of the FSMs under relevant space environmental conditions. Furthermore, a space qualification roadmap is being established to support future space missions. As part of this effort, an in-orbit demonstration of the FSM technology is planned as a payload for the fifth launch of the Nuri launch vehicle.

These results indicate the feasibility of high-performance beam steering mechanisms for future space optical communication systems.

14:45 [V-3-4]

Minimum Link Distance of Terrestrial Testbed for Emulating Satellite-to-Ground Free-Space Optical Links

Woohyeon Moon, Hoon Kim
School of EE, KAIST

Free-space optical (FSO) communication modules for satellite-to-ground links must be verified through ground-based testing before launch. However, the exact channel conditions of satellite-to-ground FSO links cannot be fully replicated in terrestrial environments. A practical solution is to construct a terrestrial testbed that introduces stronger turbulence effects than those encountered in actual satellite-to-ground links.

In this paper, we estimate the minimum link distance required for a terrestrial testbed to emulate satellite-to-ground FSO up- and downlinks. This distance is determined such that the theoretical beam statistics of the terrestrial channel are equal to or more severe than those of the satellite-to-ground channel. To validate the proposed link-distance estimation method, we carry out Monte Carlo simulations based on the split-step propagation technique. The results confirm that a terrestrial testbed designed using the proposed analysis produces channel conditions that are more severe than those of actual satellite-to-ground links.

15:00 [V-3-5]

PAT Subsystem with Adaptive Anti-Saturation Function in Free Space Laser Communications

Chan Il Yeo, Young Soon Heo, Si Woong Park, Gang Min Bae, Hyung Jun Park
Electronics and Telecommunications Research Institute

In space laser communications between low-Earth orbit (LEO) satellites moving along different orbits, position, acquisition, and tracking (PAT) is a key technology for establishing and maintaining communication links. PAT subsystems utilizing optical sensors capable of energy detection and precise positioning are primarily used in free space laser communications. However, the reduced relative communication distance between LEO satellites and the excess transmitted energy beyond the designed operating range of the space laser communication system lead to saturation of the optical sensor-based PAT subsystem, resulting in PAT failure. In this paper, we report on a PAT subsystem with adaptive anti-saturation function for free space laser communication.

This work was supported by Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea government(MIST) [No. RS-2024-00398409, Development of Optical Inter-Satellite Communication Technology for Next-Generation LEO Satellite Constellation].

15:15 [V-3-6]

Optical Link Loss Estimation from Measurements of Atmospheric Turbulence in 3-km FSO Experiments

Jungwon Choi[1], Wonseok Kang[1], Taewoo Kim[1], Seongjin Kim[1], Yong-sun Park[1,2], SangHoon Oh[1]
[1]*SPACEBEAM Inc.*
[2]*Department of Physics and Astronomy, Seoul National University*

We investigate the effects of atmospheric turbulence over a

3-km free-space optical (FSO) link and estimate the turbulence-induced link loss. The phenomena affecting the optical link include intensity fluctuations and light refraction, specifically scintillation and beam wandering. Considering these factors is essential for analyzing the link performance of free-space optical communication (FSOC) systems. We preliminarily derive the scintillation indices (σ_I^2) from beam footprint videos and received power measurements over a 3-km horizontal link using a 1,550-nm transmission laser. To evaluate strategies for reducing scintillation loss, we also calculate the scintillation indices for different aperture sizes. The atmospheric turbulence measurements offer insights into the potential application of adaptive optics in FSOC systems.

15:30 [V-3-7]

Performance Analysis of Spherical Wave-Based Tip-Tilt Compensation for 20.5 km Long-Range FSOC Links

Sang-Won Park[1], Hyung-Chul Lim[1], Dae-Young Lee[2]

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

This study elucidates the performance of a tip-tilt compensation system in mitigating atmospheric turbulence effects for long-range terrestrial free-space optical communication (FSOC). We analyze a 20.5 km horizontal link between Mt. Gamak and Mt. Daebong, a regime where the transmission distance significantly exceeds the Rayleigh range (z_R = 5.06 km) by a factor of four. Under these far-field conditions, diffractive beam spreading necessitates a spherical wave model to ensure physical fidelity over conventional plane wave assumptions. The analytical model integrates Rytov theory with spatial filter functions (G_x and G_y) to numerically isolate scale-dependent turbulence components. By incorporating a Zernike tip-tilt removal filter ($1 - F_{filter}$) based on the second-order Bessel function, we quantify the residual log-irradiance variance suppressed by the control bandwidth. Numerical simulations using the Hufnagel-Valley 5/7 and Bufton wind models demonstrate that the spherical wave approach predicts a 39% lower angle-of-arrival variance compared to plane wave assumptions, thereby mitigating over-engineered design margins.
Furthermore, we verify that a 200 Hz control bandwidth effectively stabilizes the focal plane beam wander from 2.56 μm to 0.33 μm. (RMS), maintaining the residual jitter well within the 2.33 μm diffraction limit. These findings establish a rigorous theoretical and practical foundation for the optimization of future long-range terrestrial FSOC and satellite-to-ground laser communication terminals.

15:45 [V-3-8]

Overview of CONTEC Global Optical Ground Stations for Satellite-to-Ground Free-Space Optical Communication

Seullee Lee, Taehyun Kim, Jihye Kim, Kihwan Choi

CONTEC Co., Ltd

With the rapid advancement of laser communication, free-space optical (FSO) technology has emerged as a high-speed, high-capacity solution for transmitting data from satellites to the ground. Unlike conventional radio frequency (RF) systems, which are increasingly constrained by spectrum saturation and regulatory delays in frequency allocation, FSO links leverage a broader optical bandwidth and highly directional beams to achieve higher data throughput and lower susceptibility to electromagnetic interference. As a result, FSO technology is considered a promising alternative to RF-based communication. Optical ground stations (OGS) constitute a critical component of the next-generation satellite-to-ground FSO links, serving as a high-performance and operationally reliable platform. To contribute to both domestic and international developments in this field, CONTEC Co., Ltd. has established OGS facilities in Australia and Jeju, Korea. These OGS facilities are compatible with the leading standards of CCSDS and SDA, enabling interoperability with existing terminals and supporting data rates of up to 10 Gbps.
In this paper, we provide an overview of the OGS including its specifications and operational capabilities, and also discuss its potential applications such as quantum key distribution (QKD) communication.

릴리 II

V-4 우주정책 · 거버넌스 / 우주감시

Chair: 성재동(항우연)

14:00 [V-4-1]

Key Discussions and Outcomes of the 2nd Joint Multilateral Cislunar PNT Workshop: Advancing Global Interoperability for Sustainable Lunar Exploration

Byoung-Sun Lee

Korea AeroSpace Administration (KASA)

This paper summarizes the key discussions and major outcomes of the “2nd Joint ICG-IOAG Multilateral Cislunar PNT Workshop” held in Vienna, Austria, in February 2026. As lunar exploration activities accelerate, space agencies worldwide are actively developing independent Positioning, Navigation, and Timing (PNT) systems. Consequently, ensuring international

interoperability has emerged as a critical challenge.
The workshop facilitated in-depth discussions across five core areas:

- Systems and Frameworks: Participants shared the current development status and interoperability demonstration plans of various national systems, including NASA's LunaNet and LCRNS, ESA's Moonlight, JAXA's LNSS, and ISRO's Lunar PNT system.
- Standardization and Governance: Progress on the Lunar Unified Navigation Exchange (LUNEX) format and CCSDS standardization was reported. Furthermore, international coordination strategies through the ATLAC framework and LunaNet Governance (CSLG) were discussed.
- Lunar Reference Frame and Time: Technical guidelines were presented, including roadmaps for establishing a Lunar Reference Frame and the proposed CGPM resolution for defining "Lunar Time" with traceability to UTC.
- Spectrum Management: The workshop addressed regulatory frameworks for lunar PNT services, including frequency sharing and interference mitigation strategies utilizing S-band and 3GPP technologies.
- User Equipment and Technology: Latest advancements in hardware were introduced, such as the flight results of the LuGRE experiment, ultra-small atomic clocks, and next-generation receiver technologies.

In conclusion, this workshop reaffirmed the urgent need to establish an integrated cislunar PNT infrastructure for sustainable lunar exploration. The proposed standards and technical consensus are expected to serve as the cornerstone for supporting complex multi-user missions in lunar orbit and on the surface in the coming years.

14:15 [V-4-2]

Registration of Lunar Orbiters under the Current UN Framework: Issues and Considerations from the Case of KPLO

Soyoung Chung[1], Joon Lee[1], Jiwon Lee[2], Joonwon Kang[2], Young-Joo Song[2]

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

Space object registration and mission information sharing have emerged as foundational elements for safe and sustainable lunar activities. These issues are receiving increasing attention in the international community, including among the Artemis Accords signatories and within the Action Team on Lunar Activities Consultation (ATLAC) under the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). This paper examines the limitations of current space object registration practices through selected cases of lunar orbiter missions, including Korea's first lunar orbiter, Danuri (KPLO). It shows that the existing registration regime, primarily based on the Registration Convention originally designed for Earth-orbiting satellites, does not fully reflect the operational characteristics of spacecraft operating in lunar orbit. To address these gaps, the paper reviews ongoing discussions in the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space under COPUOS concerning information-sharing pursuant to the transparency principles of Article XI. It then explores practical approaches to strengthening the registration of lunar orbiters and mission parameter sharing within the existing UN framework. Finally, the paper proposes ways to apply these measures to the extended mission and operational practices of Danuri (KPLO). By pursuing proactive and transparent approaches to registration and mission parameter sharing, Korea could contribute to best practices in the emerging governance of lunar activities.

14:30 [V-4-3]

A Comparative and Analytical Study on Space Cybersecurity Guidelines of Major Countries

Cheol Won Lee, Seyoung Baik, Deokjin Kim

The Affiliated Institute of ETRI

As space systems are utilized in various fields, including national security and the Internet, governments and private companies around the world are competing to participate in satellite and satellite service development. However, due to the inherent characteristics of satellites, such as the difficulty of physical access and security by obscurity, the software used to control and operate satellites has not been designed and operated with security in mind. Therefore, space systems may have various security vulnerabilities and may become targets for cyberattacks. Accordingly, advanced space-related nations such as the United States, France, and Japan are establishing cybersecurity guidelines to protect their space systems and are continuing efforts to respond to cyberattacks on space systems. This paper analyzes and compares the cybersecurity guidelines from the United States, France, and Japan. The United States provides standard security guidelines through NIST to encourage active private sector participation based on government best practices. Germany defines minimum technical standards that space stakeholders must adhere to. Meanwhile, France mandates space cybersecurity as a legal obligation, requiring consideration from the design phase. It also proposes security measures throughout the satellite development life cycle. Japan has established cybersecurity guidelines focusing on civilian satellites. This guideline presents specific attack scenarios and provide checklists for enhancing cybersecurity. Through this, Japanese government encourage the space industry to self-assess and improve its security posture.
South Korea has also jointly established space system

cybersecurity guidelines through collaboration between industry, academia, research institutes, and government bodies. Through these guidelines, we are continuously making efforts to improve the security level of space-related organizations. We hope that the analysis of each country's space cybersecurity guidelines derived in this paper will contribute to identifying elements for revising our country's cybersecurity guidelines.

14:45 [V-4-4]

Updates on Space Collision Risk Analysis Framework

Jaewoo Kim[1], Minchan Song[1], Eun Jung Choi[2,3], Jin Choi[2,3], Jiwoong Yu[2], Junghyun Jo[2], Hosik Kam[2], Jaemyung Ahn[1]

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

The Korea Advanced Institute of Science and Technology (KAIST) and the Korea Astronomy and Space Science Institute (KASI) have jointly developed space debris modeling capabilities to support a risk-assessment framework. Through this collaboration, we produced (i) a 3D cell-based model that diagnoses collision risk given the current states of space objects and (ii) a 1D spherical-shell model that projects the future debris environment and informs policy-relevant insights. This work outlines planned improvement directions for both models and summarizes the key updates introduced in the latest versions.

15:00 [V-4-5]

Detection and Classification of Orbital Behavior Changes Using TLE-Based Two-Stage Analysis Pipeline

Jaedong Seong

Korea Aerospace Research Institute

The rapid growth of active satellites, now exceeding 10,000 in orbit, has made continuous monitoring of orbital behavior changes essential for effective space surveillance. Distinguishing intentional maneuvers from natural orbital perturbations remains a key challenge, particularly when relying solely on publicly available Two-Line Element (TLE) data. This study presents a two-stage detection and classification pipeline that systematically identifies and categorizes orbital behavior changes across diverse satellite populations.

The proposed method employs an initial rapid-screening stage (PREFIL) that evaluates changes in orbital elements between consecutive TLE pairs, followed by a precision analysis stage using SGP4 propagation to detect characteristic convergence patterns (V-patterns) at maneuver epochs. A critical component of the pipeline is the altitude-adaptive threshold scheme, which accounts for the significant variation in atmospheric drag effects across orbital regimes—for instance, natural decay rates differ by two orders of magnitude between 400 km and 800 km altitudes. This enables the reliable discrimination of intentional maneuvers from natural orbital decay without requiring external ephemeris data.

The classification framework categorizes detected events into three primary types: intentional orbital maneuvers with Delta-V estimation in the RIC (Radial-Intrack-Crosstrack) coordinate system, natural atmospheric decay, and anomalous states such as safe-mode transitions where physical inconsistencies between computed Delta-V and observed orbital changes serve as diagnostic indicators. Validation was performed using operational data from Korean LEO satellites (CAS500-1, KOMPSAT-5), achieving 81.6% accuracy for maneuvers with altitude changes exceeding 0.3 km. Large-scale operational testing on 8,909 detections across 3,554 satellites over a 9-day period demonstrated 99.98% validity, with constellation-specific behavior patterns—including Starlink station-keeping, GEO longitude drift correction, and high-altitude constellation quiescence—correctly reflected in the classification results. The study also discusses detection limitations for small maneuvers ($\Delta a < 0.1$ km) where TLE noise becomes a dominant factor, and presents a confidence scoring system that quantifies detection reliability based on maneuver magnitude and orbital characteristics.

15:15 [V-4-6]

PASU: Design of an Ontology- and AI-Based Space Spectrum Surveillance Platform

Myungmuk Kim, Youeyun Jung, Jaedong Seong

Korea Aerosapce Research Institute

Space Situational Awareness (SSA) has traditionally focused on tracking space objects and collision avoidance. However, the rapid growth of low Earth orbit (LEO) constellations has highlighted the need for systematic surveillance of spectrum resources beyond physical orbital congestion. Space and Spectrum Situational Awareness (S3A), formally proposed at the 2025 ITU Space Sustainability Forum (SSF), extends situational awareness from the orbital domain to the radio-spectrum domain and underscores the urgency of establishing real-time monitoring, forecasting, and response capabilities for satellite spectrum interference. At present, approximately 16,000 operational satellites (payload missions) share finite spectrum resources. Yet asymmetries in spectrum and operational information across countries still force interference surveillance to rely on limited and manual analyses, creating broad blind spots. This study introduces PASU (Predictive Analysis of Spectrum Utilization), a spectrum-interference surveillance platform that operationalizes the S3A concept. PASU functions as an execution platform for the Kinetic-Dynamic layer within

a 3+1-layer ontology framework and, in linkage with static entity matching in the Semantic layer, models spatiotemporal interference relationships among satellites.
Mode 1 (DETECT) combines TLE-based orbit propagation with ITU Radio Regulations-based link-budget analysis for continuous interference monitoring. Mode 2 (FORECAST) generates a daily interference outlook from predicted orbits for early warning. Mode 3 (SIMULATE) targets what-if interference impact simulation under virtual satellite deployment and exploration of spectrum white spaces.
PASU combines an ontology framework with AI-based analysis to demonstrate the feasibility of automating space-spectrum surveillance. This presentation the S3A-driven design philosophy, the conceptual three-mode architecture, and the current prototype.

15:30 [V-4-7]

Conjunction Risk Hotspots in the Era of One Million Satellites

Seunghwan Choi[1,2], Joonghyun Ryu[1,2], Deok-Soo Kim[1,2]

[1]*SpaceMap Inc.*
[2]*Hanyang University*

The emergence of super megaconstellations in low Earth orbit (LEO) is creating unprecedented challenges for space situational awareness (SSA). In a future environment containing up to one million satellites, conjunction events and collision risks are expected to grow nonlinearly due to dense orbital interactions. This study analyzes the spatial distribution of collision risk in a one-million-satellite environment using a scalable conjunction assessment framework based on Voronoi-diagram-based geometric screening. The proposed approach efficiently excludes satellite pairs with negligible collision potential and focuses on effective high-risk candidates, enabling large-scale simulation over the 300–2,000 km LEO regime. The results show that collision risk is not uniformly distributed, but instead becomes highly concentrated in hotspot regions, particularly in specific altitude bands and orbital-plane intersection zones. These findings suggest that future SSA operations will face severe congestion in limited orbital regions, highlighting the need for hotspot-aware orbital safety management. This study provides foundational data for the design of next-generation SSA systems and collision mitigation strategies in the era of super megaconstellations.

15:45 [V-4-8]

Fundamental Research on the Development and Operational Strategy of a Radar System for Space Asset Protection

Youeyun Jung, Saehan Song, Jaedong Seong, Okchul Jung

Korea Aerospace Research Institute

This study presents a digital engineering-based design analysis and operational strategy for a fixed large-aperture parabolic tracking radar system to establish Korea's independent space traffic monitoring capability. Through digital twin simulation and systematic modeling, key radar performance parameters are quantitatively evaluated across multiple design variables, and a cost-benefit analysis is conducted to identify optimal specification candidates for phased system acquisition.
An end-to-end operational framework is proposed, encompassing event triage, observation tasking, orbit determination update, and action-level decision protocols, supported by conjunction data statistics that characterize event distribution patterns by altitude, object type, and spatial concentration. The study concludes with policy recommendations to position the radar as civilian-led space traffic management infrastructure, enabling Korea's transition from a passive data recipient to an independent co-provider in the international space safety ecosystem.

4월 24일(금) 그랜드볼룸 I

VI-1 태양 및 우주환경 III

Chair: 이창섭(극지연)

09:00 [VI-1-1]

Assessment of Space-Based Optical Observations for the Study of Atmospheric Gravity Waves and Ionospheric Dynamics

Hyosub Kil[1], Serin Jeon[2], Sunwoo Park[3], Woo Kyoung Lee[1,2], Young-Sil Kwak[1,2]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology (UST)*
[3]*Chungnam National University*

This study assesses the capability of space-based optical imaging for investigating of atmospheric gravity waves in the lower thermosphere and ionospheric morphology in the equatorial region. NASA's AWE mission data are utilized to explore the generation of gravity waves associated with terrestrial activities, and measurements of the 630.0 nm atomic oxygen emission from the Japanese IMAP mission are used to investigate ionospheric morphology, including equatorial plasma bubble structures. Preliminary analysis of AWE data from 2024 indicates that the intensity of tropical storms does not warrant gravity wave propagation to the lower thermosphere. We extend this investigation to characterize the distribution, wavelength, and size of gravity waves. While IMAP-VISI's 630 nm imagery contains information regarding the background ionosphere and

equatorial plasma bubbles, its utility for studying the former remained under-explored. The ionospheric morphology driven from 630 nm images is validated against established ionospheric climatology and existing satellite datasets. By comparing coincident optical and in-situ measurements, we evaluate the consistency of bubble dimensions across different observation platforms.

09:15 [VI-1-2]

Response of LEO-DOS Neutron Spectrometer to the May 2024 Superstorm

Jongil Jung[1], Young-Sil Kwak[1,2], Uk-Won Nam[1], Suyeon Oh[3], Won-Kee Park[1], Jongdae Sohn[1], Bongkon Moon[1]

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

The low Earth orbit space radiation dosimeter (LEO-DOS) is a space radiation measurement payload onboard NEXTSat-2, which began operations in June 2023 and recently finished its mission. LEO-DOS consists of two instruments: the particle dosimeter (PD) and the neutron spectrometer (NS). The PD measures radiation doses from charged particles, proton (>40 MeV) and electrons (>3 MeV), in the low Earth orbit (LEO), while the NS measures radiation doses from fast neutrons within the energy range of 1.6 to 8 MeV. In our previous presentation, we used PD data to summarize the characteristics of radiation dose related to solar energetic particles (SEPs), inner radiation belt (IRB), and outer radiation belt (ORB) during May 2024 superstorm. In this presentation, we focus on NS data to analyze the response of the neutron component in the LEO environment during the same period. Specifically, we investigated the differential responses between PD and NS. These results are expected to contribute to a more comprehensive understanding of variations in the LEO radiation environment.

09:30 [VI-1-3]

Improving Spatial and Temporal Resolution of SUVI/EUV Data from SDO/AIA Using AI-Model

Sumiaya Rahman[1], Bendict Lawrance[2], Ashraf Siddique[3], Yong-Jae Moon[1,4], Suhyun Kim[5], Hyun-Jin Jeong[6]

[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*Department of AI-based Big Data Management, Gangseo University*
[3]*Graduate School of Artificial Intelligence, Ulsan National Institute of Science & Technology (UNIST)*
[4]*G-LAMP NEXUS Institute, School of Space Research, Kyung Hee University*
[5]*College of Software, School of Computer Science and Engineering, Kyung Hee University*
[6]*Center for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium*

The Solar Ultraviolet Imager (SUVI) / extreme ultraviolet (EUV) provides larger field of view extending out to ~3 solar radii but lower spatial and higher temporal resolution than SDO/AIA data. To address this limitation, we consider AI–based approach to improve both spatial and temporal resolution SUVI/ EUV data. We train Pix2PixCC-Unet model SDO/AIA (1 k × 1 k) data as input and SUVI/EUV L2 HDR (1 k × 1 k) as output. During testing, the AI-model generates high resolution SUVI/EUV L2 HDR (4 k × 4 k). A total of 1440 pairs of SDO/AIA data and SUVI/EUVI L2 HDR are considered for training, validation, and testing from 2020 January to 2025 August. The results of this study are as follows. First, the AI-based model enhances the spatial resolution of low-resolution SUVI/EUV L2 HDR data 4 times both on the solar surface and the limb area up to 2 solar radii. Second, the AI-model generated SUVI/EUV L2 HDR from SDO/AIA data exhibits high CC, PSNR, MS-SSIM value with lower temporal resolution. Third, The AI-generated SUVI/EUV L2 HDR data are have better saturation handling than SDO/AIA during major solar events. In future, we will apply Al-models to denoise and to enhance spatial resolution of SUVI/EUV L1b from SDO/AIA data up to approximately 3 solar radii.

09:45 [VI-1-4]

Denoising SDO/AIA Images for Enhanced Coronal Observations by Deep Learning

Daeil Kim[1], Yong-jae Moon[1,2], Seungheon Shin[1], Junmu Youn[1], Mingyu Jeon[1], Yeoungjae Kim[1], Seungwoo Ahn[1]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

In this study, we develop deep learning models for denoising solar EUV images, specifically for the SDO/AIA 94 Åchannel. We compare supervised and self-supervised learning models, along with a conventional noise-gating technique, using data from 2011 to 2021. The self-supervised model uses the noisy image itself as a target, while the supervised model uses stacked data. Our main results are as follows. First, the supervised model demonstrates the best performance among the three methods. It achieves a background noise level of 0.03, a Signal-to-Noise Ratio (SNR) of 86.48, and a Contrast-to-Noise Ratio (CNR) of 65.19. These values are significantly better than those of the original observation (noise level: 0.21, SNR: 14.27,

CNR: 11.24). Second, our model successfully restores faint structures, enabling the detection of a transverse loop oscillation with a period of 299 s, which was difficult to detect in the original observation. The oscillation period is consistent with R. S. White et al. (2012), which was obtained using 131 Å.Our study suggests that our deep models can be useful tools for analysing physical phenomena of the solar corona from low-SNR data.

10:00 [VI-1-5]

Forecast of SYM-H Index under Strong Southward IMF Condition by Deep Learning

Jihyeon Son[1], Yong-Jae Moon[2,3], Young-Sil Kwak[4,5], Seungheon Shin[3]

[1]*Center for Heliophysics Research, Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, Kyung Hee University*
[3]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[4]*Division of Fundamental Astronomy, Korea Astronomy and Space Science Institute*
[5]*University of Science and Technology*

In this study, we propose a deep learning model to forecast the SYM-H index up to 12 hours ahead under strong southward interplanetary magnetic field (IMF) Bz conditions (Bz $\leq$ −3 nT for at least 6 hours), which is well-known as the main driver of geomagnetic storms. The input data consist of 5-min resolution solar wind parameters (IMF components, solar wind speed, density, dynamic pressure, and electric field) from OMNIWeb, averaged over 30-minute intervals, with a 12-hour lookback window. Our proposed model adopts a multi-layer perceptron-based encoder-decoder architecture following the Time-series Dense Encoder (TiDE) framework. Our results are as follows. First, our model achieves comparable or better performance in terms of RMSE and correlation coefficient relative to previous Dst and SYM-H prediction models. Second, our model successfully predicts the minimum SYM-H value and its timing within the 12-hour forecast window. Third, we demonstrate that the model produces reliable SYM-H forecast profiles during storm periods or even beyond the strict southward Bz criterion used for training. To our knowledge, this is the first study to forecast a geomagnetic index under strong IMF southward conditions, which is under an explicit condition on the state of the primary storm driver, and we expect that this approach can serve as a useful tool for space weather forecasting.

릴리 I

VI-2 화성탐사 과학미션

Chair: 한정열(천문연)

09:00 [VI-2-1]

Mission Scenario Planning and Conceptual Design of an ENA Imager for Future Korean Mars Exploration

Kwang-Ho Choi[1], Dae-Young Lee[1], Ji-Hyeon Yoo[2], Seunguk Lee[3]

[1]*Chungbuk National University*
[2]*KASI*
[3]*KBSI*

Quantifying the escape of the Martian atmosphere is a critical objective for understanding planetary evolution, as the loss of oxygen serves as a vital proxy for reconstructing the historical depletion of liquid water on Mars. This study focuses on developing a mission scenario and the conceptual design of a next-generation Energetic Neutral Atom (ENA) imager, specifically optimized for observing Oxygen-ENA (O-ENA) flux to backtrack the origin and evolution of Martian water. To overcome the technical limitations observed in heritage missions such as Mars Express and Tianwen-1, we have established an integrated research framework that aligns orbital dynamics with instrument performance requirements.
Currently, the mission-specific orbital profile has been established by analyzing the effective generation regions of O-ENAs in the Martian tail and dayside plume. Based on this scenario, the primary instrument specifications, including the field of view and detection logic, have been derived to ensure high-fidelity global imaging. The proposed design incorporates advanced electron optics and coincidence logic to enhance signal sensitivity while effectively suppressing background noise. In this study, we briefly present the current status of mission planning and the technical roadmap for South Korea's independent Mars atmospheric research.

09:15 [VI-2-2]

Planetary Subsurface Exploration Mission Development

Gi-Hyuk Choi, Dae-Young Kim

Korea Aerospace Research Institute

Much of the planetary subsurface structure remains unknown, and many technical challenges remain. Research has been conducted to find large-scale subsurface structures and water few kilometers deep beneath the Moon and Mars using

one-dimensional ~10 MHz low-frequency sounder radars. NASA's Mars Reconnaissance Orbiter (MRO) ('06) discovered a layer of subsurface water beneath Mars using the 20 MHz low-frequency sounder radar SHARAD, and Japan JAXA's SELENE lunar probe ('07) explored the lunar subsurface using the 5 MHz low-frequency sounder radar (LRS). In 2018, the MARSIS 2-5 MHz low-frequency sounder radar onboard the European Space Agency's (ESA) Mars Express discovered a 20 km diameter saline subglacial lake 1.5 km beneath the Martian south polar plain. Recently, small, low-frequency ground-penetrating radars have been deployed on lunar and Martian landers to study the subsurface. China's Chang'e-3 lunar lander ('13) operated a 60/500 MHz low- frequency sounder ground-penetrating radar (GPR), and NASA's Mars Rover Perseverance ('20) used a 150-1,200 MHz low-frequency GPR, RIMFAX, to explore the subsurface structure of their landing sites. The primary mission of low-frequency sounder radars is to search for water and ice beneath the Moon and Mars. Water has a high permittivity (ε) of 80, making it easy to detect by strongly reflecting radio waves. However, ice has a permittivity of approximately 3.0, similar to that of soil and rock, making it more difficult to detect. Therefore, the polarization changes in the reflected signal based on permittivity must be carefully analyzed. Previously used sounder-type radars only provide one-dimensional depth information, requiring synthetic aperture radar (SAR) to obtain two-dimensional planar position information. Recently, with the advancement of radar technology, a space exploration mission is being planned to search for water down to a depth of 10 meters under the surface of Mars using the multinational International Mars Ice Mapper (IMIM) SAR radar of NASA, ESA, and JAXA. In addition, a space exploration mission is proposed to launch an small neutrino detector (< 10 kg) into low Earth orbit to statistically observe and analyze for a long time neutrinos emitted in large quantities from the Sun (10^9 /cm^2/sec), similar to a medical X-ray CT, to take tomographic images of the Earth and planets. I think it is an interesting space exploration mission that Korea can pursue in the near future because it is easer and cheaper than a radar mission.

09:30 [VI-2-3]

Payload Architecture for High-Reliability Mars Surface Exploration: The MIRINAE and NABI Systems

Minsup Jeong[1], Chae Kyung Sim[1,2], Dukhang Lee[1,2], Bongkon Moon[1,2], Jeong-Yeol Han[1,2]

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

To ensure the success of international Mars missions in the 2030s, we present a robust, zero-mechanism payload architecture designed to withstand the harsh Martian environment. This suite consists of two innovative instruments: MIRINAE and NABI. MIRINAE is a multi-spectral stereo camera that eliminates the need for traditional filter wheels by employing a specialized Bayer filter system. It enables simultaneous 8-band spectral imaging and 3D terrain reconstruction, supporting both mineralogical analysis and autonomous rover navigation. Complementing this, NABI is a zenith-pointing, dual-wavelength (532 nm / 1064 nm) micro LiDAR. By utilizing a hybrid detection system without moving parts, it provides continuous vertical profiling of atmospheric dust and ice. Together, these solid-state instruments offer a high-reliability solution for atmospheric monitoring and landing safety, demonstrating a new paradigm for next-generation deep-space exploration payloads.

09:45 [VI-2-4]

Payload Engineering Concepts for Mars Rover/Lander Missions: MarsVision 3D Multispectral Polarimetric Camera and a 100 mm-Class Telescope

Jeong-Yeol Han[1,2], Chae Kyung Sim[1,2], Minsup Jeong[1,2], DukHang Lee[1,2], Bongkon Moon[1,2], Seung-Kyun Ryu[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*IMAero Co., Ltd.*

This study presents preliminary engineering concepts for two optical payloads for Mars rover/lander missions. MarsVision is a VNIR multispectral, polarimetric, and stereo imaging system for co-registered 3D terrain reconstruction and surface-property assessment under dusty, variable illumination conditions. We also investigate a compact 100 mm-class reflective telescope for ultra-high-resolution surface imaging, atmospheric monitoring, and observations of Earth and Phobos/Deimos. Key engineering considerations include payload architecture, calibration, pointing performance, optical stability, and SWaP (size, weight, and power) constraints.

10:00 [VI-2-5]

Development of a Wide-Field Visible Camera Concept for Observing Martian Aurora and Airglow

Woo Kyoung Lee[1,2], Hyosub Kil[1,3], Jaewook Lee[1], Se-Heon Jeong[1], Serin Jeon[1,2], Chanhaeng Lee[1], Jeong-Heon Kim[1]

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

As the Korea AeroSpace Administration (KASA) prepares for

upcoming Mars exploration, securing strategic observational data on the Martian environment is essential. This study presents a concept design for a high-sensitivity wide-field visible camera intended for future Mars landing missions. While orbital observations have provided valuable data, they are limited in tracking the continuous temporal evolution of atmospheric phenomena at specific locations. To overcome this, we propose a stationary wide-field imager capable of monitoring Martian aurora and oxygen airglow (557.7 nm), providing critical insights into solar wind interaction and atmospheric loss. The proposed concept leverages the proven optical heritage of the ROKITS onboard the Compact Advanced Satellite 500 (CAS500)-3, optimized for the Martian surface environment. The design focuses on a compact, high-speed optical system and a high-quantum-efficiency sensor to capture faint emissions under low-light conditions. By inheriting established domestic space technologies, this project aims to minimize development risk while maximizing scientific output. This payload concept is expected to play a pivotal role in international collaborative missions, establishing South Korea's leadership in the global Mars exploration roadmap and providing essential environmental data for future human habitation.

사파이어 I

VI-3 우주교육 문화유산

Chair: 조영인(천문연)

09:00 [VI-3-1]

A Study on Space Education for Expanding Public Engagement in Space

Shin-Myeong Kim, Jae-Hee Seo

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As space activities increasingly influence science, technology, industry, and national security, space education is gaining importance as fundamental literacy that enables citizens to understand and participate in the emerging space society. This study examines the role of space education in expanding public engagement with space and discusses strategic directions for its development. The study highlights several key considerations: building social consensus and educational infrastructure for space education, strengthening networks among related institutions and stakeholders, expanding space-related content and programs within formal school education, securing specialized educators, and enhancing space education programs for diverse groups. These efforts are essential for establishing a sustainable and inclusive space education ecosystem that supports the broader expansion of space awareness and participation.

09:15 [VI-3-2]

Reconceptualizing Astronomical Observation through Measurement Constraints: A Laboratory Integration of Interferometry and Quantum Sensing

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While educational astronomy typically presents observation as simply looking through a telescope, modern astronomical research heavily depends on phase-sensitive correlation, noise-limited signal processing, and inference driven by physical models. To address this gap, we introduce a modular laboratory curriculum designed for introductory optics and modern physics courses. This sequence reconceptualizes observation as an inference process bounded by measurement limits, utilizing hands-on, engineering-focused experiments: (i) Michelson and Mach-Zehnder interferometry (covering alignment, stability, and fringe dynamics), (ii) polarization studies highlighting how system configurations affect information extraction, and (iii) optically detected magnetic resonance (ODMR) using nitrogen-vacancy (NV) centers to infer magnetic fields from spectral data. These experimental stations are adaptable, functioning either as qualitative, exploratory setups or as rigorous quantitative exercises (incorporating fringe visibility calculations, Jones/Stokes formalism, and Lorentzian curve fitting with uncertainty propagation).During a pilot study involving a transition cohort (utilizing a single-group pre- and post-test design; N = 66, matched n = 59), student performance on the 16-item Astronomical Measurement Limits Survey (AMLS) improved from a mean of 3.98 (SD = 0.47) to 4.41 (SD = 0.46), indicating a substantial within-group effect size (d z $\approx$ 1.0). Additionally, accuracy on four related conceptual questions rose from an average proportion correct of 0.62 (SD = 0.28) to 0.78 (SD = 0.25). Because this study lacked a control group and relied on immediate post-testing, these results provide formative evidence for a short-term cognitive shift toward measurement-constrained reasoning, rather than definitive causal proof. To facilitate replication and future research, instructor guides, assessment tools, and data analysis codes are provided.

09:30 [VI-3-3]

Analysis of the Gap between Altmetric Attention and Research Trends in Astronomy and Space Science

Jung-Jae Jang[1], Ji-Won Park[1,2], Yong-Gi Kim[1,2]

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This study empirically investigated the gap between temporary public interest and actual research trends in an environment where the importance of science communication and education is increasing. To this end, top-tier journals in the field of astronomy and space science, based on the JCR 5-year Impact Factor, were categorized into Specialist Journals (e.g., ApJL, A&A) and Generalist Journals (e.g., Nature, Science). Metadata and Altmetric Attention Score (AAS) data from 2016 to 2025 were collected. To ensure academic validity, the collected literature was classified into 11 major academic fields by applying the top-level (Level 1) structure of the Unified Astronomy Thesaurus (UAT) provided by the American Astronomical Society, and topics were derived through Structural Topic Modeling (STM). The analysis methodology involved assigning the topics derived through STM to the 11 Level 1 categories and focusing on the differences in AAS changes between the Generalist and Specialist groups. Through this approach, the study analyzed the gap between public attention and academic research trends across these two journal categories.

09:45 [VI-3-4]

Projection Principles and Astronomical Significance of the *Ganpyeong-Ilgu* and *Hongae-Ilgu*

Sang Hyuk Kim[1], Byeong-Hee Mihn[1,2,3], Ki-Won Lee[4]

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

The *Ganpyeong-Ilgu* and *Hongae-Ilgu*, engraved on a single stone slab in 1785, are Korean treasure sundials. Both are horizontal sundials and represent the apparent motion of the Sun using two distinct projection methods: orthographic and stereographic projections. In this study, the structural and geometrical characteristics of these two instruments, which are currently housed at the National Palace Museum of Korea, are analyzed, and their astronomical significance is examined. These instruments We mathematically reconstruct season and hour lines by applying the inscribed latitude 37°39′15″ and the obliquity of the ecliptic 23°29′. A comparative analysis shows that these reconstructed lines well align with those engraved lines on the heritages. We further suggest that instead of a fixed gnomon, a movable device, such as the *Gyehyeong*, may have been employed to measure the season and hour. Moreover, the results demonstrate that the two sundials form an integrated timekeeping system, in which their distinct projection schemes mutually compensate for each structural limitation; this system is suitable for precise time measurements.

10:00 [VI-3-5]

Chinese Knowledge on Mechanical Clocks in the Early 19th Century

Byeong-Hee Mihn[1,2,3], Sang Hyuk Kim[1], Kyoung-Uk Nam[4], Hong Soon Choi[1,2], Ki-won Lee[5]

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The *Gaohu Mengqiu* (高厚蒙求) is a Chinese literature work that offers a comprehensive overview on astronomy, horology, and geography, influenced by Western science and technology. It was compiled by Xu Chaojun (徐朝俊, birth and death dates are unknown) in five volumes between 1807 and 1829. This study analyzes the *Ziming Zhongbiao Tufa* (自鳴鐘表圖法, Illustrated Methods for Clock and Watch) chapter of the third volume. Often abbreviated as the *Zhongbiao Tufa* (鐘表圖法), this chapter focuses on mechanical clocks manufactured and repaired in China, detailing clock nomenclatures, component diagrams, gear train arrangements, and fabrication techniques. Additionally, it explains precise methods for the disassembly and assembly of clocks, as well as systematic maintenance procedures for various cases, such as when the movement of a clock stops or when the alarm functions irregularly. Notably, the complex illustrations and technical methodologies suggest that mechanical clocks were commercially prevalent and practically utilized in China around the nineteenth century. We believe that this study contributes to understanding historical development of horology in China.

그랜드볼룸 I

VII-1 태양 및 우주환경 IV

Chair: 이시백(경희대)

10:25 [VII-1-1]

Responses of the Middle Atmosphere by Strong Geomagnetic Storms in 2024

Ji-Hee Lee[1], Geonhwa Jee[1,2]

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Geomagnetic disturbances enhance the precipitation of energetic electrons and protons (eV–MeV) from geospace into the Earth's atmosphere. When these particles collide with neutral atmospheric constituents, they produce nitrogen oxides ($NOx = N + NO + NO_2$) and odd hydrogen species ($HOx = H + OH + HO_2$) in the middle and upper atmosphere. Both NOx and HOx play a

central role in atmospheric ozone (O_3) chemistry, particularly in the stratosphere and mesosphere, where they drive catalytic cycles that lead to ozone depletion. In this study, We investigated the atmospheric responses in the polar middle atmosphere of the SH during nine intense geomagnetic storm events from April to October 2024. The measurements are used for the temperature, ozone, and odd hydrogen oxide observation data from the MLS and ACE-FTS.

10:40 [VII-1-2]

A Data-Driven Empirical Formula for Solar Wind Speed Prediction by Symbolic Regression

Seungwoo Ahn[1,2], Youngjae Kim[1,2], Mingyu Jeon[1,2], Hyun-Jin Jeong[1,3], Daeil Kim[1,2], Junmu Youn[1,2], Yong-Jae Moon[1,2,4]

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[2]*G-LAMP NEXUS Institute, Kyung Hee University*
[3]*Centre for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Belgium*
[4]*Department of Astronomy and Space Science, Kyung Hee University*

In this study, we apply symbolic regression (SR) to solar wind speed data at 1 AU to derive a data-driven equation as a function of coronal hole (CH) parameters. We use two CH parameters—the fractional CH area (A_{CH}) and the CH contrast (P_{CH})—derived from Solar Dynamics Observatory/Atmospheric Imaging Assembly 193 and 211 Å images together with prior solar wind speeds as input data. We train the SR model using data spanning from May 2010 to December 2024, with the dataset divided into a training set (January–September) and a test set (October–December) to consider the solar cycle effect. Using PySR, we derive interpretable equations for solar wind speed and select an optimal equation via cross-validation. The SR model derives a new data-driven equation given by $\sqrt{A_{CH} \times P_{CH}} + \sqrt{v_{t-27d} \times v_{slow}}$, achieving an RMSE of 79.2 km/s and a correlation coefficient of 0.55. This equation outperforms other traditional empirical models, suggesting that it captures key relationships between the CH parameters and solar wind speed. The first term indicates the acceleration component governed by CHs and the second term indicates the background component given by the geometric mean of the 27-day persistence speed and the slow solar wind speed. These results suggest that the SR model provides an explicit and physically interpretable relationship between CH parameters and solar wind speed.

10:55 [VII-1-3]

Real-Time Extrapolation of Solar Force-Free Fields Using a Physics-Informed Neural Operator

Mingyu Jeon[1,2], Hyun-Jin Jeong[1,3], Yong-Jae Moon[1,2,4], Jihye Kang[2,4], Kanya Kusano[5]

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[5]*Institute for Space-Earth Environmental Research, Nagoya University, Japan*

Solar coronal magnetic fields store the magnetic energy that drives solar eruptions, such as flares and coronal mass ejections, which significantly impact space weather. Nonlinear force-free fields (NLFFFs) are commonly used to model these 3D coronal magnetic fields. We develop a physics-informed neural operator (PINO) model that learns the solution operator mapping 2D photospheric vector magnetic fields to 3D NLFFFs. The model is trained using a hybrid loss function comprising physics losses from NLFFF partial differential equations and data losses from target NLFFF solutions. We first validate our approach against an analytical NLFFF model. Subsequently, we train and evaluate the model using 2,327 numerically computed NLFFF samples from 211 active regions (ARs) in the Institute for Space-Earth Environmental Research (ISEE) database. Our results demonstrate that the trained PINO model can calculate NLFFFs in less than one second on a single consumer-grade GPU, enabling real-time reconstruction of 3D coronal magnetic fields. For 30 ARs in the test set, our artificial intelligence (AI)-generated NLFFFs are qualitatively and quantitatively similar to the target NLFFFs. Additionally, the magnetic energy evolution of the AI-generated NLFFFs for AR 11158 is consistent with both the target ISEE NLFFFs and those obtained from existing methods. We anticipate that our methodology could be extended to full MHD equations for achieving more complete real-time reconstructions of the solar corona.

11:10 [VII-1-4]

Upper Atmospheric Responses to G4+ Geomagnetic Storms Across the Solar Activity Cycle

Changsup Lee[1,2], Geonhwa Jee[1,2], Jeong-Han Kim[1], Jieun Kim[1]

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

Geomagnetic storms are one of the most effective ways in which energy originating from space can enter the Earth's atmosphere. While numerous studies have examined thermospheric responses to strong geomagnetic storms in the polar cap and auroral regions, our understanding of storm-time effects in the mesosphere and lower thermosphere (MLT) over sub-auroral latitudes remains limited due to higher neutral density and the

presence of closed magnetic field lines. In this study, we use long-term meteor radar observations from King Sejong Station spanning 2015–2026 to investigate the impacts of multiple G4-class and stronger geomagnetic storms on sub-auroral MLT dynamics and the D-region ionosphere.

11:25 [VII-1-5]

SWA-GPT: Space Weather Assistant with Multi-Agent System

Seungheon Shin[1], Yong-Jae Moon[1,2], Jihyeon Son[3]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department Astronomy and Space Science, Kyung Hee University*
[3]*Center for Heliophysics Research, Korea Astronomy and Space Science Institute*

Recent advances in large language models (LLMs) have enabled the development of decision-support assistants for scientific operations. In this work, we present an updated version of SWA-GPT (Space Weather Assistant with GPT), designed for space weather monitoring and forecasting with a particular focus on the three NOAA scales: radio blackouts (R), solar radiation storms (S), and geomagnetic storms (G). Our earlier single-agent SWA-GPT primarily supported web-based retrieval and conversational summarization of multi-source space weather information, enabling rapid situational awareness from heterogeneous operational data streams. To accommodate more complex forecasting workflows, we introduce a multi-agent architecture that decomposes the task into specialized agents, each tailored to a specific operational scale (R, S, or G). Each agent applies scale-specific context engineering and reasoning, while a supervisor agent integrates cross-scale outputs into a coherent operational assessment for decision support. Preliminary evaluations suggest that the multi-agent SWA-GPT yields more consistent scale-specific interpretations, improves the completeness and structure of operational reports, and supports more reliable analyses compared to the prior single-agent system.

11:40 [VII-1-6]

Sun-Earth Connection in the Last Millennium Using Korean Historical Sunspot and Red Aurora Records

Rok-soon Kim[1], Hong-Jin Yang[1,2], Kyung-Suk Cho[1,2], Hisashi Hayakawa[3], Yukinaga Miyashita[1,2]

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[2]*University of Science and Technology*
[3]*Institute for Space-Earth Environmental Research, Nagoya University*

Korean historical chronicles contain detailed records of astronomical phenomena spanning more than two millennia, providing an excellent source for scientific research due to their continuity and consistency. In particular, historical records of sunspots and auroras include detailed information on their size and intensity, enabling quantitative analysis of past solar activity. In this study, we analyzed records from the 10th to the 18th century and identified 38 sunspots and 24 associated red auroras. We also compared solar activity during warm and cool periods before and after AD 1300. Large sunspots appeared more often during the warm period, while auroras were more frequently recorded in the cool period, and the records show a weak but positive link between sunspot size and auroral intensity. Our results show that stronger auroras were more often linked with larger sunspots, suggesting a connection between solar activity and Earth's response in the past. Two events in 1185 and 1556 appear particularly strong and may be comparable to major modern space-weather events.

11:55 [VII-1-7]

Discovering Empirical Relationships from Data by Symbolic Regression: Examples in Solar Physics and Space Weather

Yong-Jae Moon[1,2], Youngjae Kim[1], Seungwoo Ahn[1], Jihyeon Son[3]

[1]*G-LAMP NEXUS Institute/School of Space Research, Kyung Hee University*
[2]*Department of Space Science , Kyung Hee University*
[3]*Korea Astronomy and Space Science Institute*

While machine learning (ML) has become a ubiquitous tool in data-driven science, the interpretability issue inherent in standard "black-box" models remains a significant barrier to understanding the underlying physics. Symbolic Regression (SR) offers a compelling solution as an interpretable AI technique. Unlike traditional regression analysis, which merely optimizes coefficients within a predetermined functional form, SR explores the space of mathematical expressions without constraints to discover the functional form itself that best describes the data. This unique capability provides high potential for full model transparency, facilitates causal inference, and allows for the seamless integration of domain knowledge. In this talk, we present several examples in solar physics and space weather to find empirical relationships by SR: (1) solar major flare occurrence probability as a function of active region parameters, (2) solar wind speed at the Earth as a function of corona hole parameters, and (3) Dst minimum as a function of solar wind parameters.

릴리 I

VII-2 K-RadCube (Artemis II CubeSat)

Chair: 이덕행(천문연)

10:25 [VII-2-1]

K-RadCube: A 12U Secondary Payload for NASA's Artemis II to Measure Space Radiation in the Van Allen Belts

Chae Kyung Sim[1,2], Young-Jun Choi[1], Dukhang Lee[1,2], Jehyuck Shin[1], Donguk Song[1], Seul-Min Baek[1], Woohyeong Seol[1], K-RadCube Team

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

K-RadCube is a 12U CubeSat mission developed by the Korea Astronomy and Space Science Institute (KASI). It has been selected as a secondary payload for NASA's Artemis II mission, set to be deployed into a high Earth orbit from the Orion Stage Adapter. The primary scientific goal is to measure the space radiation environment within the Van Allen radiation belts and evaluate its biological impact on astronauts traveling to interplanetary destinations. Beyond its scientific goals, the mission aims to verify operational reliability and failure modes of domestic semiconductor devices in the space environment. To achieve its mission, the satellite utilizes a water-based self-propulsion system to perform critical orbit-raising maneuvers and stabilize its high Earth trajectory. These operations are supported by a global ground station network, enabling precise orbit determination and data acquisition across a trajectory reaching altitudes up to 70,000 km. This presentation provides an introduction to the K-RadCube project, detailing its system configuration, operational scenarios, and tiered success criteria aimed at advancing Korea's space exploration capabilities.

10:40 [VII-2-2]

System Development of K-RadCube: A 12U CubeSat for Space Radiation Measurement on NASA's Artemis II Mission

Seongwhan Lee[1], Hyojeong Lee[1], Chae Kyung Sim[2,3], Dukhang Lee[2,3], Jehyuck Shin[2], Donguk Song[2], Seul-Min Baek[2], Woo-Hyeong Seol[2], Uk-Won Nam[2], Young-Jun Choi[2], K-RadCube Team

[1]*Nara Space Technology Inc.*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

K-RadCube is a 12U CubeSat developed as a Secondary Payload (SPL) for NASA's Artemis II crewed lunar mission. This paper presents the design, development, and verification of the satellite bus system developed by Nara Space Technology (NST).

K-RadCube is deployed from the Orion Stage Adapter (OSA) and operates in a High Earth Orbit (HEO) with an apogee of approximately 70,000 km. Since the initial orbit has a perigee below the atmospheric reentry altitude, the spacecraft first establishes communication with ground stations, then executes two successive propulsive maneuvers at apogee to raise the perigee to approximately 150 km and subsequently to approximately 200 km, thereby achieving the final mission orbit. The primary engineering challenges involved extending a Low Earth Orbit (LEO)-heritage CubeSat platform to the HEO environment, encompassing post-deployment initialization and ground contact acquisition sequences, structural integrity against Space Launch System (SLS) launch loads, and efficient data downlink under highly constrained communication windows. As an SPL on a crewed mission, K-RadCube was also required to comply with NASA's rigorous safety standards. The entire development lifecycle was compressed into approximately one year, making this a highly challenging endeavor.

10:55 [VII-2-3]

Safety Assurance of K-RadCube as a Secondary Payload on the Artemis II Mission

Jehyuck Shin[1], Dukhang Lee[1,2], Hyojeong Lee[3], Seongwhan Lee[3], Donguk Song[1], Chae Kyung Sim[1,2], Seul-Min Baek[1], Uk-Won Nam[1], Woo-Hyeong Seol[1], Young-Jun Choi[1], Taewan Kim[4], Hyeonggu Kim[4], K-RadCube Team

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[3]*Nara Space Technology Inc.*
[4]*KT SAT*

K-RadCube is a 12U CubeSat developed to measure the space radiation environment along a high Earth orbit. The CubeSat is manifested as a Secondary Payload (SPL) on NASA's Artemis II mission, which is the first crewed flight of the Orion spacecraft launched by the Space Launch System. As a SPL on the human spaceflight mission, K-RadCube was required to comply with NASA's stringent safety standards to ensure no hazards to the crew, primary vehicles and ground facilities. To meet safety requirements, K-RadCube underwent NASA's dedicated payload safety review process, in which potential hazards are systematically identified, assessed, and mitigated through design and operational controls. In this talk, we introduce the NASA safety review framework applied to Artemis II SPLs and describe the safety verification activities performed for K-RadCube.

11:10 [VII-2-4]

Lessons Learned from K-RadCube LEOP

Operations

Donguk Song[1], Chae Kyung Sim[1,2], Dukhang Lee[1,2], Jehyuck Shin[1], Seul-Min Back[1], Woo-Hyeong Seol[1], Young-Jun Choi[1], Uk-Won Nam[1], Won-Kee Park[1], Kwangwon Lee[3], Hyojeong Lee[3], Seongwhan Lee[3], Taewan Kim[4], Hyeonggu Kim[4], K-RadCube Team

[1]*Korea Astronomy and Space Science Institute*
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[3]*Nara Space Technology Inc.*
[4]*KT SAT*

K-RadCube is a 12U CubeSat designed to measure the radiation environment of the Van Allen belts surrounding the Earth. In April 2026, it was successfully launched as one of the secondary payloads of the Artemis II mission aboard NASA's Space Launch System. At 5 hours and 30 minutes after launch, it was deployed into the High Earth Orbit (HEO) and subsequently carried out the Launch and Early Orbit Phase (LEOP). K-RadCube is the first Korean CubeSat to be deployed and operated in the HEO, as well as the first Korean CubeSat to participate in a crewed mission. To meet safety requirements for the crewed mission, a steam-based electrothermal propulsion system was chosen instead of a conventional chemical thruster. While this system is safer than traditional chemical propulsion, it requires relatively high electrical power during thrust. This created a key operational challenge, executing orbit-raising maneuvers while maintaining conservative battery Depth of Discharge limits. Additionally, the challenge was further complicated by the short, tightly scheduled communication windows in the HEO, which demand precise coordination between maneuvering and ground-contact opportunities. In this talk, we present operational strategies developed to address these constraints for K-RadCube operations and share lessons learned from the actual mission.

11:25 [VII-2-5]

K-RAD-PD LET Spectrometer for Radiation Belt Studies Using the K-RadCube Mission

Uk-Won Nam[1], Woo-Hyeong Seol[1], Won-kee Park[1], Sunghwan Kim[2], Sukwon Youn[3], Chae Kyung Sim[1,4], Dukhang Lee[1,4], Jehyuck Shin[1], Donguk Song[1], Seul-Min Back[1], Young-Jun Choi[1], Kwangwon Lee[5], Hyojeong Lee[5], Seongwhan Lee[5]

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[4]*University of Science and Technology*
[5]*Nara Space Technology Inc.*

This study focuses on the physical design and calibration of the K-RAD-PD (Particle Detector), a Linear Energy Transfer (LET) spectrometer developed for high-fidelity space radiation monitoring. The instrument utilizes an n-type silicon photodiode sensor with an effective area of 20 × 20 mm and a thickness of 650 μm. To capture a broad dynamic range of radiation environments, the system employs a dual-gain architecture with a 15 : 1 ratio, enabling simultaneous measurement of Low-LET (0.2–8.07 keV/μm) and High-LET (2.53–117.83 keV/μm) spectra. Energy calibration was performed using Cs-137, Sr-90, and Am-241 sources to establish a linear relationship between ADC channels and deposited energy. The K-RAD-PD implements an algorithm based on the Benton equation to convert the absorbed dose in silicon (D_{Si}) to a tissue-equivalent water dose (D_{H2O}), accounting for biological quality factors (Q) as defined by ICRP-60. The detector is designed to effectively differentiate between trapped proton contributions in the Inner Radiation Belt and electron fluxes in the Outer Radiation Belt. It is anticipated that these high-resolution LET measurements will provide a critical physical basis for quantifying biological radiation risks and validating the shielding effectiveness of satellite materials in the complex Low Earth Orbit environment.

11:40 [VII-2-6]

K-RadCube's Subpayload of Samsung Explorative Memory and Logic Devices for Space Experiment

Jin-Woo Han[1], Youngseok Woo[1], Kyutae Kim[1], Uk-Won Nam[2], Chae Kyung Sim[2,3], Dukhang Lee[2,3], Jehyuck Shin[2], Donguk Song[2], Seul-Min Baek[2], Woo-Hyeong Seol[2], Young-Jun Choi[2]

[1]*Device Solutions CTO, Samsung Electronics*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

Samsung's subpayload is a real-time system designed to evaluate the characteristics of seven different memory and logic devices on a board. The objective is to monitor their behavioral changes and radiation tolerance across the mission profile. While the main payload monitors radiation dose and energy, our subpayload also tracks local temperature profiles. By jointly analyzing radiation, temperature, and electrical data, this experiment can enhance our fundamental understanding of semiconductor device physics. This project can serve as an experimental platform for new space era. Moreover, the specific set of high-performance logic and memory devices selected for this mission is expected to set a benchmark for space tolerance, paving the way for future technological advancements.

11:55 [VII-2-7]

Comprehensive Analysis of In-Orbit Radiation Environment and Real-Time Degradation of DRAM Devices in an Elliptical Earth Orbit up to 70,000 km

Shingyu Choi[1], Sulhwan Lee[1], Uk-Won Nam[2], Chae Kyung Sim[2,3], Dukhang Lee[2,3], Jehyuck Shin[2], Donguk Song[2], Seul-Min Baek[2], Woo-Hyeong Seol[2], Young-Jun Choi[2]

[1]*SK hynix Inc.*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*

This study presents a comprehensive analysis of in-orbit radiation measurements and the real-time degradation behavior of Dynamic Random Access Memory (DRAM) devices obtained during the elliptical orbit mission of K-RadCube, covering altitudes from several hundred kilometers to approximately 70,000 km. Space radiation can induce defects in the silicon lattice, which may lead to increased leakage currents through temperature-dependent mechanisms such as Shockley-Read-Hall (SRH) generation and thermionic field emission (TFE) [1-3]. To accurately evaluate the influence of the space radiation environment under the operational temperature range of −5℃ to 45℃, temperature sensors were installed in proximity to the DRAM devices, enabling continuous monitoring of device temperature throughout the mission. Real-time radiation data collected along the orbit—including the South Atlantic Anomaly (SAA) region in low Earth orbit, the Van Allen radiation belts, and the outer magnetospheric region extending to ~70,000 km altitude—were systematically correlated with the recorded temperature data and observed device degradation events. Through this integrated analysis, the impact of the space radiation environment on DRAM device reliability was quantitatively characterized. The findings of this study provide valuable insights into the radiation-induced degradation mechanisms of DRAM devices in space environments and contribute to improving radiation tolerance of semiconductor device resilience for space environments. This work is expected to support the advancement of next-generation space computing and space-based data infrastructure.

This paper was result of the research project supported by SK hynix Inc.

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포스터발표 논문 초록

발표시간 : 4월 23일(목)
집중발표 16:10~17:50

[P-1] A Preliminary Polarimetric Study of Lunar Surface Mineral Simulants

Eunji Yi[1,2], Chae Kyung Sim[1,2], Keewook Yi[3], Eunjin Cho[1], Minsup Jeong[1], Serin Kim[1,2]

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[3]*Korea Basic Science Institute*

Polarimetry of the lunar surface provides essential clues regarding the physical properties of the lunar regolith such as grain size, microstructure, and porosity. Previous experimental studies have established a relationship between the maximum degree of linear polarization (P_{max}) and median grain size ($\langle d \rangle$). These studies are based primarily on lunar basaltic soil samples that resemble lunar maria, imposing an inherent compositional bias that limits their applicability across the lunar globe. To mitigate these constraints, this study incorporates an extended range of mineral analogues, enhancing the representativeness of the empirically-determined P_{max}-$\langle d \rangle$ relationship for diverse compositions and grain sizes found on the lunar surface. Target samples include rock powders of highland-representative anorthosite and mare-representative basalt, as well as pure olivine, pyroxene, ilmenite, hematite, and the lunar mare simulant JSC-1A. To quantify and compare the polarimetric behavior as a function of $\langle d \rangle$, the samples were dry-sieved into seven size fractions: >500 μm, 250–500 μm, 150–250 μm, 90–150 μm, 75–90 μm, 45–75 μm, and <45 μm. Each size fraction was analyzed using a Scanning Electron Microscope (SEM) to verify particle size and shape, an attached Energy Dispersive X-ray Spectrometer (EDS) to confirm elemental ratios, and a Visible and Near-Infrared (VNIR) spectrograph to examine mineralogical compositions. The P_{max} of each sample was measured using a linear polarization filter and a goniometer setup. This research aims to validate the P_{max} $-\langle d \rangle$ relationship for various areas on the Moon, improving the interpretation of the polarimetric observations from orbit, i.e., data from the Wide-Angle Polarimetric Camera (PolCam) onboard Danuri (Korea Pathfinder Lunar Orbiter, KPLO).

[P-2] A Network-Based Approach to Lunar Magnetic Anomaly Observation Using Deployable M-Box Probes

Yesun Ahn[1], Jeonghwan Jang[1], Ho Jin[1], Hyeonhu Park[2], Minjae Kim[1], Sanghwa Kim[1], Khan-Hyuk Kim[1], Chae Kyung Sim[3]

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Compared to the traditional single point measurements for the lunar magnetic anomalies, altitude-dependent distribution or observations in an array format can revolutionize our understanding of the lunar surface magnetic field and its interaction with the space environment. To enable such observations, this study proposes a conceptual design for a small, box-shaped Magnetic Field Observation Box (M-Box) probe, which can be deployed via surface ejection or acting as a master station equipped with multiple M-Box units for deployment. Each M-Box integrates a magnetometer, battery, communication module, and attitude determination sensors. The utilization of these M-Boxes is expected to provide novel observational data, offering breakthrough insights into long-standing questions regarding the lunar surface magnetic environment.

[P-3] Opposition Effect on Highly Porous Silica Analogues Fabricated by 3D Printing

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The opposition effect is a sharp surge in brightness on the planetary surface. This effect is influenced by the fine structure of regolith, such as porosity. Many laboratory experiments have been conducted to investigate the opposition effect on a highly porous surface. However, the relationship is still not fully understood because it is difficult to produce and preserve highly porous materials in Earth's environment. 3D printing is one of the state-of-the-art techniques for overcoming this difficulty. In this study, we fabricated highly porous analogues using 3D-printing techniques with silica powders. The porosity of samples was controlled by adjusting the wt% of silica powder. We conducted laboratory measurements of the opposition effect of the silica analogues at small phase angles at 405 nm. We measured the reflectance of six samples over a phase angle range of 1.4° to 5.0°. To characterize the opposition effect of

the samples, we defined a slope parameter based on the absolute value of the tangential slope of the phase curve. We compared the slope parameter at phase angles of 1.4°, 3.0°, and 5.0° for all samples.
The experimental results confirmed that all samples exhibit high reflectance near the minimum phase angle, consistent with the typical phase curve of a planetary surface. Samples with high porosity showed a stronger opposition effect, as indicated by a larger slope parameter. However, the reflectance did not increase monotonically with porosity. It suggests that fine-structure properties, rather than porosity alone, may influence the reflectance of some samples.

[P-4] Feasibility Study of a Crew-Deployable Magnetometer for Manned Lunar Surface Exploration

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We are developing a lunar surface magnetometer to investigate magnetic anomalies and space environment variations. Leveraging the technical heritage of the Korea pathfinder lunar orbiter MAGnetometer (KMAG), this instrument is designed for future landing missions. It is currently being developed as a model for integration into the crew-deployable lunar surface science station led by the Korea Astronomy and Space Science Institute (KASI).
In magnetic field observations, it is crucial to minimize magnetic noise interference generated by electronic equipment. We have designed MAG unit that allows for flexible placement away from the station. This deployment method is structurally simpler and more stable compared to traditional boom mechanisms.
To achieve both high precision and wide-range detection, the instrument integrates two FluxGate Magnetometers (FGMs) and an Anisotropic Magneto-Resistive (AMR) sensor. The FGMs have a resolution of 0.2 nT and a noise level of $\leq$ 50 pT/$\sqrt{}$Hz at 1 Hz, while the AMR sensor captures strong magnetic fields up to ± 80 μT that exceed the FGM's limits. Furthermore, this multi-sensor configuration facilitates enhanced noise analysis. An accelerometer embedded in the AMR module measures the attitude to calibrate and transform the magnetic field vectors. In this presentation, we introduce the design and technical specifications of the magnetometer optimized for acquiring high-quality lunar magnetic data during human-led missions.

[P-5] Inverse Estimation of Vertical Thermal Structure and Heat Source Parameters of Venus Atmosphere using PINNs

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This study proposes a new approach to inversely estimate the vertical thermal structure of the Venus atmosphere from sparse observational data using Physics-Informed Neura Networks (PINNs), which integrate data-driven learning with physical laws. To overcome the high computational costs of traditional General Circulation Models (GCMs) and the spatio-temporal limitations of observational data, 1D radiative-convective equilibrium and hydrostatic equilibrium equations are incorporated into the loss function. Specifically, the atmospheric heat sources are parameterized as a sum of generalized Gaussian distributions corresponding to the surface, cloud, and top of atmosphere. The model is designed to extract effective parameters, including the intensity and width of each heat source as well as the cooling scale, during the training process. Comparative validation with Pioneer Venus Orbiter (PVO) data and GCM results confirms that the proposed model successfully reconstructs the characteristic temperature and pressure profiles of Venus at a physically plausible level, effectively explaining the atmospheric structure through interpretable physical parameters. These findings suggest that PINNs are a powerful tool for estimating planetary atmospheric properties in data-limited settings. Future research will incorporate the two-stream approximation to capture multiple scattering effects, advancing the current simplified approach into a more sophisticated radiative transfer model to ensure robust physical accuracy in 1D atmospheric structure estimations.

[P-6] The Necessity of Concurrent Lunar Surface and Orbital Magnetic Field Measurements: Insights from Anomalous Phenomena

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Since the Moon does not have a global magnetic field, the interaction between the solar wind and the lunar surface is a key factor in determining the local magnetic environment, which in turn influences surface charging and dust dynamics. Therefore, various magnetic phenomena associated with the ambient external magnetic field can be expected on the lunar surface. These include magnetic field pile-up resulting from solar wind interactions and the lunar wake environment.
In this study, we compare magnetic field measurements obtained from the Apollo 12 Lunar Surface Magnetometer (LSM) and the Explorer 35 magnetometer. We identify a simultaneous

observation event when the Apollo 12 LSM was located in the lunar terminator region. During this event, the magnetic field exhibits a variation of approximately 10 nT in the GSE Z component. Notably, a corresponding variation was also observed by the Explorer 35 magnetometer.
However, this simultaneous observation appears difficult to explain solely by existing models such as magnetic field pile-up or the lunar wake. This suggests the need for more extensive simultaneous observation data. Consequently, such anomalous phenomena highlight the necessity of concurrent magnetic field measurements both on the lunar surface and in orbit for future lunar exploration.

[P-7] Estimation of 557.7 nm Auroral Emission Altitude from Two-Station All-Sky Imaging at Jang Bogo Station and Cape Hallett

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We introduce a multi-filter all-sky camera (FASC) installed at Jang Bogo Station (JBS) for multi-wavelength auroral imaging to study three-dimensional auroral structures and emission altitudes. The FASC observes auroral emissions at 630.0 nm (OI red line), 557.7 nm (OI green line), and 427.8 nm (N_2^+ first negative band) with a temporal resolution of approximately 15 seconds per cycle.
In coordination with an all-sky camera (ASC) at Cape Hallett, located about 320 km from JBS, the system enables stereoscopic auroral observations from two ground-based sites.
This study presents the instrument configuration and observational approach, together with initial examples of coordinated observations between the two stations. The present analysis uses 557.7 nm (green line) data, and auroral emission altitudes are inferred by comparing the auroral morphology observed from both locations. These initial results demonstrate the capability of coordinated ground-based observations to estimate auroral emission altitudes.

[P-8] Large Thermospheric Wind Enhancements in the Polar Cap Observed at Jang Bogo Station during Substorm Expansion Phases

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Large enhancements of thermospheric winds were identified at Jang Bogo Station (JBS), Antarctica, during substorm expansion phases. Using Fabry-Perot interferometer (FPI) measurements, we examine eight representative events exhibiting significant increases in neutral wind speed in the southern polar cap during 2018–2021. The events show a clear MLT-dependent pattern: enhancements are predominantly meridional in the midnight sector and zonal in the dawn sector, corresponding to strengthened anti-sunward neutral winds. Observations from the JBS-VIPIR-Dynasonde (JVD) indicate increases in ion drift velocity and ionospheric plasma density, along with poleward expansion of the auroral oval. These conditions suggest enhanced ion drag and pressure gradient forcing during the events, indicating enhanced ionosphere-thermosphere coupling. In addition, the zonal wind enhancements in the dawn sector appear to be related to IMF By conditions.

[P-9] Radial Evolution of Solar Wind Plasma Properties from 0.1 to 1 AU Using Parker Solar Probe and OMNI Data

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Understanding how solar wind plasma evolves from the Sun through interplanetary space is essential. The Parker Solar Probe (PSP) provides unprecedented in situ measurements of the young solar wind close to the Sun, enabling direct investigation of its evolution when combined with near-Earth observations. In this study, we investigate the radial evolution of solar wind plasma properties, including speed, density, and temperature, between ~0.1 AU and 1 AU. To compare PSP measurements with near-Earth solar wind data from the OMNI dataset, we consider intervals when PSP is aligned with the Sun–Earth line. Assuming radial propagation of the solar wind, we first estimate its arrival time at Earth using the average solar wind speed measured by PSP. The time lag between the PSP and OMNI measurements is then refined by maximizing their correlation. This analysis allows us to trace the same solar wind streams as they propagate outward through the inner heliosphere and to examine how key plasma properties evolve between ~0.1 AU and 1 AU. Our study provides insight into the physical processes governing the radial evolution of the solar wind from the near-Sun region to near-Earth space, including its acceleration and expansion.

[P-10] Statistical Analysis of High-Latitude Geomagnetic Disturbances Associated with Solar Wind Conditions

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Large geomagnetic disturbances at high latitudes were frequently observed even during periods of low solar activity. Such disturbances are known to be associated with high-speed solar wind accompanied by a southward interplanetary magnetic field (IMF). In this study, we revisit the well-known relationship between high-latitude geomagnetic disturbances and solar wind properties. We first carefully identify geomagnetic disturbance events—including their onset, expansion, recovery, and termination—from the AL index time series over the interval 2018–2020. The events are then categorized into various subgroups based on their characteristics, such as weak versus large disturbances and short-versus long-duration ones. Superposed epoch analysis is applied to solar wind and IMF parameters measured at the Sun-Earth L1 point around the onset of these events to identify characteristic trends in the solar wind conditions associated with different event subgroups. The results provide new statistical insights into solar wind conditions associated with high-latitude geomagnetic disturbances during periods of exceptionally low solar activity.

[P-11] Localized Density Duct Versus Banded Chorus Generation: Ray Tracing Analysis

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It is well known that banded whistler-mode chorus waves observed in the inner magnetosphere exhibit a distinct power gap near half the equatorial electron cyclotron frequency. One proposed mechanism for the formation of this gap invokes frequency-dependent propagation effects associated with localized density enhancement ducts. In this framework, often referred to as the multiple-source hypothesis, lower-band waves are guided along magnetic field lines within an enhancement duct from an equatorial source region, whereas upper-band waves propagate unducted from a spatially separated remote source. However, recent statistical observational studies of localized density peak structures have reported no strong correlation between the peak-to-base density ratio of ducts and key chorus characteristics. This apparent inconsistency between the duct-driven generation hypothesis and observational constraints motivates a more quantitative assessment of the role of density ducts in power gap formation. In this study, we perform a parametric ray-tracing analysis constrained by observationally derived density duct parameters to quantify the role of density ducts in power gap formation. By systematically varying duct size and peak-to-base density ratio, we explore the parameter space for optimal gap formation and derive the expected correlations between duct properties and banded chorus spectral characteristics. The results provide a physics-based assessment of the duct-induced generation hypothesis and its consistency with observational constraints.

[P-12] Statistical Survey of He-Band EMIC Waves at Geosynchronous Orbit Observed by GK2A Across Solar Minimum to Maximum under Varying Geomagnetic Conditions

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Electromagnetic ion cyclotron (EMIC) waves are transverse, left-hand polarized plasma waves driven by proton temperature anisotropy ($T_\perp > T_\parallel$). He-band EMIC waves, sensitive to cold plasmaspheric density near the plasmapause, warrant a consistent quiet-disturbed comparison within the same geosynchronous orbit. However, few studies have performed a uniform, multi-parameter statistical characterization of these waves within a single-orbit framework, beyond occurrence alone. In this study, we investigate the statistical properties of He-band EMIC waves observed at geosynchronous orbit using 1-s resolution magnetic field measurements from the SOSMAG instrument onboard GEO-KOMPSAT-2A (GK2A) during 2019–2025. An automated detection procedure is applied to identify He-band EMIC events and to quantify polarization, wave normal angle (WNA), central frequency, bandwidth, and event duration. The detected events are predominantly close to left-hand circular polarization, and WNA generally exhibits an oblique distribution. The f/f_O histogram shows a bimodal distribution with a localized depletion (reduced counts) over a specific range. This depletion is more evident under quiet conditions in the MLT–f/f_O plane. In addition, spectral width consistently increases under disturbed conditions characterized by Kp $\approx$ 1, AE^* (3-h maximum AE index) $\approx$ 400, $P_{dyn} \approx$ 2–4 nPa. When events are classified according to these criteria, the occurrence regions differ clearly between the quiet-time and disturbed-time subsets, suggesting distinct generation and propagation environments under different geomagnetic conditions.

[P-13] Initial Observations of Thermospheric Neutral Winds by a Newly Installed Bohyunsan FPI: Validation through Comparison with Meteor Radar and Response to Geomagnetic Storms

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This presentation introduces the newly installed Fabry-Perot Interferometer (FPI) at the Bohyunsan Optical Astronomy Observatory and its initial observational achievements since January 2025. Using long-term observational data from January 2025 to March 2026, we compared and analyzed the neutral wind components derived from the FPI 557.7 nm emission line with those from the Gyeryong meteor radar. Despite the geographical distance between the two instruments, the results demonstrated significant consistency, confirming that both instruments effectively capture the common neutral wind dynamics over the Korean Peninsula. Notably, during the S4-solar radiation strom event in January 18–19 2026, distinct variations in neutral winds were observed at an altitude of approximately 250 km. A dramatic reversal from the typical northward (eastward) dominance to a strong southward (westward) flow was successfully captured, reflecting the dynamic response of the upper atmosphere to geomagnetic disturbances. These findings underscore the high utility of FPI data as a fundamental resource for understanding the ionosphere-thermosphere coupling mechanisms over the Korean Peninsula.

[P-14] Influence of Tropospheric Variability on Migrating Semidiurnal Tide in the Mesosphere and Lower Thermosphere

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The influence of tropospheric Northern Annular Mode (NAM) on the migrating semidiurnal tide (SW2) in the mesosphere and lower thermosphere (MLT) is investigated using the Specified-Dynamics version of the Whole Atmosphere Community Climate Model with thermosphere and ionosphere extension (SD-WACCM-X). During neutral stratospheric polar vortex conditions, composite analysis of the positive and negative phases of the tropospheric NAM revealed distinct signals in SW2 amplitude. Composite zonal-mean zonal wind anomalies in the middle atmosphere further suggest that the SW2 response may be related to changes in the propagation conditions. These results highlight a potential pathway through which tropospheric variability can influence tidal structure in the upper atmosphere.

[P-15] Hemispheric Asymmetry in the Ionospheric Response to the January 2026 Geomagnetic Storm in the Asian Sector

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This study investigates the spatiotemporal evolution of the ionosphere during the intense geomagnetic storm of January 2026 (minimum Dst ≈ −218 nT) using multiple observational datasets. Electron density measurements from the Swarm A/B/C satellites, Madrigal TEC data, and thermospheric wind fields from the HWM14 model were analyzed to characterize storm-time ionospheric responses. A significant inter-hemispheric asymmetry in plasma density occurred in the Asian longitude sector (120–140°E) during the storm's main phase, characterized by density enhancement in the Northern and reduction in the Southern Hemisphere. However, this asymmetry reversed during the recovery phase. Wind measurements over Korea suggest that the density enhancement at northern midlatitudes during the main phase is associated with shifts in global wind patterns; wind convergence at these latitudes may have generated the observed asymmetry. The subequent reversal during the recovery phase is attributed to chances in the wind circulation alongside the extension of neutral composition disturbances toward low latitudes. This study evaluates the combined effects of neutral winds and vertical ExB drift on the formation of hemispheric asymmetry during the main phase. To this end, we conduct controlled numerical experiments using the SAMI2 model, assessing the relative roles of these drivers through a comparative analysis of model results and observations.

[P-16] Solar Wind Conditions Associated with Large East-West Asymmetries in Proton Flux (>10 MeV) Observed by GOES

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Since 2010, the Geostationary Operational Environmental Satellites (GOES) have been equipped with two identical particle detectors facing eastward and westward. An asymmetry may arise in multi-MeV proton flux measurements from these two detectors. Larger flux is expected in the westward- and eastward-facing detectors when the gyrocenters of protons lie inside and outside the geostationary orbit, respectively. This phenomenon is known as the east–west effect. In this study, we analyzed the time profiles of >10 MeV proton flux measured by the westward- and eastward-facing detectors onboard GOES during major solar proton events (SPEs) from 2010 to 2020. Our analysis reveals that while most SPEs exhibit little east–west asymmetry, a few events show significantly higher peak fluxes in the eastward-facing detector. To identify the physical drivers of these asymmetries, we examined solar wind and interplanetary magnetic field (IMF) conditions at the L1 point together with geomagnetic indices. We find that pronounced

asymmetries tend to occur during periods of enhanced solar wind dynamic pressure and southward IMF. Under these conditions, the magnetopause may be compressed to near or even inside the geostationary orbit, causing the gyrocenters of >10 MeV protons to lie inside the orbit and thereby increasing their detection probability in the eastward-facing detector. These results suggest that solar wind–driven magnetospheric compression plays an important role in producing large east–west asymmetries in GOES proton flux measurements.

[P-17] Deep Learning-Based Detection of Ionospheric Plasma Irregularities Using VHF Radar Observations

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The ionosphere plays a crucial role in space weather processes; however, quantitative analysis of radar observations remains challenging. The Korea Astronomy and Space Science Institute (KASI) Very High Frequency (VHF) radar systems produce two-dimensional images of the E-layer, including radial velocity, signal-to-noise ratio (SNR), signal power, and spectral width. These images contain signatures of plasma irregularities, but their identification largely relies on manual interpretation. In this study, we developed an automated deep-learning-based segmentation framework for ionospheric radar images. The dataset consists of fixed-size images (800 × 310 pixels) labeled into two classes: background and plasma irregularities. To address the highly variable morphology of plasma irregularities under noisy conditions, we employed the DeepLabV3+ architecture with a ResNet backbone. The model was trained and validated using radar observations collected between 2021 and 2023.

Our results demonstrate that the proposed method achieves an Intersection over Union (IoU) of 78.23% for the plasma irregularity class. This framework enables reliable and automated detection of plasma irregularities from VHF radar observations. This research was founded by the Republic of Korea Air Force Space Operations Group Research Program (2024UMM1468(00)). The data used in this study were provided through the cooperation of the Republic of Korea Air Force and KASI.

[P-18] Observation of Polar Cap Patches Using an All-Sky Camera at Jang Bogo Station, Antarctica

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Polar cap patches are regions of enhanced electron density in the F-region ionosphere that typically drifts across the polar cap from the dayside to the nightside by magnetospheric convection. When observed at the 630.0 nm wavelength using filtered all-sky cameras (F-ASC), these ionospheric structures appear as airglow patches, which are localized bright region of airglow emissions and can be considered to be an optical manifestation of the polar cap patches. In the absence of aurora, such airglow patches can be detected in F-ASC observations. In this study, we compare polar cap patches observed by the Vertical Incidence Pulsed Ionospheric Radar (VIPIR) with F-ASC observations of airglow patches at Jang Bogo Station (JBS), Antarctica. We present a few cases of electron density enhancement detected by VIPIR in the absence of aurora, along with corresponding airglow patches simultaneously observed by the F-ASC.

[P-19] Characteristics of Ionospheric Tilts Associated with Electron Density Variations Observed by VIPIR/Dynasonde at Jang Bogo Station, Antarctica

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The ionospheric electron density distribution is highly inhomogeneous, particularly, in the polar region where there exist various structures such as polar cap patches, polar holes, and polar cap boundary that can cause tilts in the ionospheric density layers. The Jang Bogo Station (JBS) in Antarctica is located near the boundary between the polar cap and the auroral oval, making it ideal for investigating the ionospheric tilts in the polar region. The ionospheric sounding radar, referred to as JVD (Jang Bogo Vertical Incidence Pulsed Ionospheric Radar with Dynasonde analysis), has been in operation since 2017 to monitor not only conventional ionospheric parameters such as electron density profiles and ion drift velocities, but also ionospheric tilts that indicate local horizontal gradient in the ionospheric electron density over JBS. In this study, we analyzed ionospheric electron density distributions and tilts derived from JVD observations during the period from 2017 to 2025 to investigate the characteristics of ionospheric tilts associated with corresponding electron density distributions over JBS.

[P-20] A Preliminary Study of Limb Flare Forecasting Using EUV Images and Explainable AI

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Building on Lee et al. (2024), who investigated limb flare prediction using EUV intensity information from SDO/AIA observations, we extend the approach by incorporating running difference EUV images and explainable AI. A preprocessing pipeline including AIA data calibration, image registration, and fixed field-of-view cropping is implemented to construct EUV image sequences. Limb masking is applied to isolate regions near the solar limb and suppress contributions from the disk center. As an initial experiment, convolutional neural network (CNN) models are applied to explore the feasibility of limb flare forecasting using these data. Preliminary results will be presented together with explainable AI to highlight image regions that contribute to the model predictions and to investigate potential EUV features associated with flare initiation near the solar limb.

[P-21] Multiscale Structure of Near-Sun Heliospheric Current Sheet Crossings: Large-Scale Envelopes and Embedded Small-Scale Current Sheets Observed by Parker Solar Probe

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Using Parker Solar Probe observations, we study the multiscale structure of heliospheric current sheet (HCS) crossings by treating each crossing as a large-scale envelope containing embedded small-scale current sheets (SCSs). We identify 105 HCS events (2018–2024) and compile a catalog of SCS candidates inside each HCS. To reduce observational bias, radial occurrence is evaluated using counts normalized by PSP dwell time; within $r \leq 0.25$ AU the HCS rate, and the jet-like subset rate, are enhanced toward perihelion. For events with plasma coverage (83 HCSs), 22.9% show jet-like flows consistent with reconnection-like exhausts, which appear more frequently closer to the Sun (to be verified using strict diagnostics in a testable subset). Multifurcated crossings are common (25.7% overall; 56.5% in the encounter subset), supporting a structured-envelope view of near-Sun HCSs. We also examine sign-reversed RTN components, envelope normals, and preliminary SCS statistics toward establishing quantitative links between large-scale and small-scale structures.

[P-22] Transient Brightenings as Pre-Flare Precursors: Preliminary Result

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We make a preliminary study on the EUV transient brightenings as a candidate of the precursor of solar major flares stronger than M1 class. We use SDO/AIA 1600 A data during the preflare phase (8 hours) of 21 flares in 2012. The Transient brightenings are defined as bright points whoes intensity is larger than 5 sigma and the background vlaue. The 8 hours are dividied into 16 sectors. For each sector, we estimate the mean number of brightening pixels and its hit-map weighted value. We find that there is no significant difference of these estimations among the sectors. It is only found that there are noticeable enhancements of EUV brightening patches about 139 minutes before the major flares. Our results imply that the observed EUV brightenings correspond to the pre-flare activity of solar flares, often seen in GOES X-ray.

[P-23] Periodicity Analysis of Pulsating Aurora Using High-Temporal-Resolution NIR Images from e-POP/FAI

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Auroral emissions offer crucial insights into the magnetosphere-ionosphere coupling within the near-Earth space environment. Among various types, pulsating aurora exhibits rapid brightness variations that reflect the dynamic wave-particle interactions in geospace. However, quantifying these temporal characteristics using traditional satellite imagers is often limited, as scanning-type sensors confuse spatial and temporal variations. In this study, we use Near-Infrared (NIR) observations from the Fast Auroral Imager (FAI) onboard the Enhanced Polar Outflow Probe (e-POP) to perform a detailed periodicity analysis of pulsating aurora.

By analyzing 380 sets of e-POP/FAI NIR images from 2015, with DMSP/SSUSI ultraviolet images providing contextual auroral identification, we demonstrate that the high-cadence imaging of e-POP/FAI effectively captures the intrinsic temporal dynamics of pulsating aurora. Spectral analysis reveals dominant oscillation periods ranging from 4 to 6 s. These results highlight that high-temporal-resolution optical observations from low-Earth orbit are essential for resolving the rapid evolution of pulsating aurora, providing a robust platform for investigating geospace dynamics that are otherwise elusive to scanning-type satellite instruments.

[P-24] Study of Signal Variation with Lunar Position in the Geomagnetic Tail

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Korea Aerospace Research Institute

The signal features are changed when the Moon pass into geomagnatic tail. A plasma density and a magnetic field strength induce the variation of signal SNR, which evaluates the signal's quality, RSS, which indicates the singnal's strength, and Doppler shift related to time delay. In this poster we'll present our research plan on the differences in signal characteristics when the Moon is inside and outside geomanetic tail. We will compare plasma density, signal delay, and signal stability inside and outside the Earth's magnetic tail. To investigate signal characteristic differences, we will use LRO/Mini_RF payload raw data (level 1), LRO/CRaTER raw data (level 1) to examine plasma density differences, and SPICE Kernels data to determine lunar position. When processing and analyzing the data, we will need to remove the time delay effects of the Earth's convection layer and ionosphere, and we will interpret the time delay as a change in refractive index due to the medium. These results will ultimately be applied and utilized in the S-band (2,483.5–2,500 MHz).

[P-25] Performance Evaluation of Onboard AI Compression for Solar Observation Data Transmission Using Jetson Orin Nano

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To alleviate downlink bandwidth constraints in satellite observation data, we evaluate a deep learning-based onboard AI compression system on the NVIDIA Jetson Orin Nano. As future deep space missions demand increasingly high data rates, onboard compression is becoming a critical technology for reducing communication costs. Applying the CompressAI (Cheng2020) model to NASA SDO/AIA solar images (211 Å, 193 Å), we demonstrate a nearly 8-fold increase in compression ratio compared to JPEG while achieving a near-lossless Multi-Scale Structural Similarity (MS-SSIM) of approximately 1.00. Experiments are conducted on the Jetson Orin Nano (8 GB, 15 W mode) using 1,024 × 1,024 downscaled images due to memory constraints, with compression performance measured in terms of Bits Per Pixel (BPP), PSNR, MS-SSIM, and power efficiency. Although onboard AI-based compression has higher power consumption and processing latency due to deep learning inference overhead, our results confirm that it can significantly reduce transmitted data volume. As a next step we will focus on hardware-specific optimization (e.g., TensorRT) and Differential Emission Measure (DEM)-based physical validity verification.

[P-26] An Analysis of Standard Payload Rack Requirements for Undersea Platforms

Joohee Lee, Younkyu Kim, Ikhyeon Choi

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A standardized payload experiment rack that can be used in common is installed inside the experimental module of the International Space Station. The standardized rack structure provides flexibility to users by enabling compatibility of experimental equipment developed by various users. The rack is designed with a modular structure and makes it easy to install various experimental equipment.
Installing such a standard experimental rack in an inner module of an undersea structure under similar conditions will provide users with various advantages. In addition, standard racks should provide scientific experimental users with a standardized interface for in-lab installation and functional implementation. In this paper, the system requirements and interface conditions required to develop standard racks available in closed environments such as submarine platforms and space stations were analyzed.

[P-27] Development of a Dual-Beam Tracking System for Optical Wireless Communication and Its Application to Satellite Gimbals

Jae-Seong Shin[1], Junoh Lee[1], Yeongho Shin[2], Sunghoon Cho[2], Dongsoo Choi[2], Sun-Je Kim[1]

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This study presents our recent achievements of development of a dual-layer beam tracking system for satellite optical wireless communication. We utilized a camera and a quadrant photodiode (QPD) to extract real-time centroid coordinates of laser beams under simulated disturbances (Fig. 1(a)). Fig. 1(b) describes the designed structure of gimbal stage where dual beam tracking system is equipped.
Recently, optical wireless communication (OWC) has gained increasing attention for high-speed satellite data transmission. Highly directional laser beams require precise pointing, acquisition, and tracking (PAT) mechanisms to maintain reliable communication links. In this work, we report the development of a dual-layer tracking architecture that integrates image-based coarse tracking with QPD-based fine tracking for centroid coordinate extraction. An FSM is employed to emulate beam jitter induced by platform disturbances, enabling the functional

validation of the tracking software. The proposed approach, focusing on real-time coordinate processing, serves as a technical basis for future space optical communication platforms and beam stabilization systems.

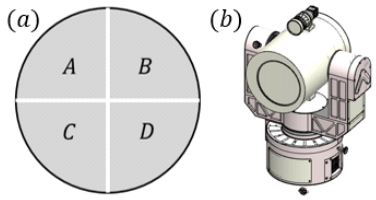


Fig. 1. (a) Quadrant Photodiode (QPD) sensor for high-precision fine tracking. (b) Structural design of the gimbal stage.

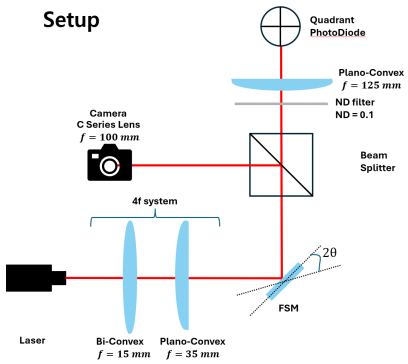


Fig. 2. Schematic of the dual-laser beam tracking experimental setup.

[P-28] AI-Based TIF Depth and Volume Prediction for Space Optical Materials

Youngseok Lee[1,2], Jeong-Yeol Han[1,2], Seung Ho Han[1,2], Jiwoo Lee[1,2]

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The fabrication of mirrors used in space exploration requires nanometer-level precision polishing, and for this purpose, the material removal amount must be quantitatively predicted. Such prediction can be performed using the Tool Influence Function (TIF), which can be calculated from Preston's equation. However, due to factors not considered in Preston's equation, there is a limitation in accurately predicting the TIF using the equation alone. Therefore, we performed TIF prediction using an artificial intelligence-based regression model. Depth and volume data obtained from the TIF were used to train the artificial intelligence models separately, and predictions were performed to evaluate the prediction accuracy. In addition, the prediction accuracies of the two physical quantities were compared to identify the quantity that better reflects the polishing characteristics, and the generality of the comparison results was verified by conducting the study on Cordierite, SiC, and Al-Si. The prediction results show that, for all three materials, the Mean Absolute Error (MAE) of the volume prediction model was lower than that of the depth prediction model. This indicates that TIF volume more effectively reflects polishing characteristics and is suitable as a predictive indicator for the design and control of precision polishing processes.

[P-29] Improving the Performance of Low Vacuum Pumps in Small-Sized Thermal Vacuum Chamber

Sung-wook Park

Korea Aerospace Research Institute

The Korea Aerospace Research Institute is operating two types of small-sized thermal vacuum chambers for part-level thermal vacuum tests. The low-vacuum pumps in the two chambers are required to be replaced due to recent failure and aging. This paper describes the selection and replacement results of the low-vacuum pump.

[P-30] Physical Interpretation of Launch Shock Based on Impulse and Structural Dynamic Response

Jong-Hyub Jun, Jong-Min Im, Hee-Kwang Eun, Nam-Jin Moon, Seon-Je Jo, Jin Park, Chang-Rae Cho, Tae-Seok Oh

Korea Aerospace Research Institute

Launch shock events, such as pyrotechnic separations and stage releases, produce extremely short-duration transient loads with high acceleration levels. Physically, shock can be understood as an impulse that causes a rapid change in momentum over a very short contact time. As the contact duration decreases, the excitation contains increasingly broadband frequency content. When this impulsive input propagates through spacecraft structures, the resulting response is governed by structural dynamics and natural frequencies, typically appearing as a decaying oscillatory motion (ring-down). This impulse-based perspective helps clarify the physical origin of launch shock and supports the interpretation of shock response spectra (SRS) used in spacecraft qualification testing.

[P-31] Establishing a High-Precision Vacuum Measurement System via Uncertainty Evaluation and Verification of Vacuum Sensors

Ji-Hoon Choi, Hee-jun Seo, Seon-gi Baek, Geun-sik Kim, Seong-uk Park, Ji-seok Kim, Gyu-min Oh, Seung-mo Hong

Korea Aerospace Research Institute

This study proposes a method for evaluating and verifying the measurement uncertainty of vacuum sensors to ensure the reliability of satellite thermal vacuum tests conducted at the Korea Aerospace Research Institute (KARI). Accurate vacuum measurement, essential for establishing ultra-high vacuum conditions within chambers for simulating space environments, heavily relies on the reliability of the sensors. Therefore, this research analyzes various error factors in the vacuum sensor measurement process, calculates systematic and standard uncertainties, and evaluates the overall measurement uncertainty. Furthermore, uncertainty verification is performed by applying it to an actual vacuum system, and improvement strategies are explored to secure foundational data for constructing a high-precision measurement system. This study specifically utilizes a multi-gauge sensor capable of directly connecting to vacuum equipment and measuring a wide range from atmospheric pressure to ultra-high vacuum. The results of this research are expected to contribute to the establishment of a high-precision measurement system based on vacuum sensors and to quality control.

[P-32] Design Study of a High-Efficiency Thermal Radiation Device through Measurement and Analysis of Thermal Conductivity of Copper Plates by Connection Methods

Keun-Shik Kim, Ji-Seok Kim, Sung-Wook Park, SunKi Baek, Hee-Jun Seo, Ji-Hoon Choi, KyuMin Oh

Korea Aerospace Research Institute

Satellites are exposed to the extreme thermal environments of outer space after launch; therefore, accurate ground-based thermal environment simulation tests are essential for mission success. In particular, the design of thermal radiation devices that substitute for solar radiation is a critical factor directly linked to the reliability of space environment simulation tests. In this study, the thermal conduction characteristics according to the structural features of copper plates used as thermal transfer media were analyzed to improve the performance of thermal radiation devices. To this end, copper plate specimens fabricated using four different connection methods were designed and produced, and the heat transfer performance of each specimen was comparatively evaluated. Each connection structure was designed to ensure heat transfer performance while simultaneously minimizing the thermal deformation of the copper plates. Experiments were conducted under atmospheric pressure and high-vacuum conditions with a constant heat input. Based on the data measured through temperature sensors, the thermal conduction characteristics of the copper plates according to the connection methods and the performance differences depending on environmental conditions were analyzed. The results of this study quantitatively present the thermal conduction characteristics according to the copper plate connection structures and the performance changes in atmospheric and vacuum environments. These findings are expected to be utilized as fundamental data for designing high-efficiency thermal radiation devices applicable to future space environment simulation tests.

[P-33] Automation of the Lifting System Working Platform for a Large Thermal Vacuum Chamber and Surface Machining of the Approach Fixture Working Platform

SunKi Baek, Sung-Wook Park, KeunShik Kim, Hee-Jun Seo, Ji-Seok Kim, Ji-Hoon Choi, KyuMin Oh

Korea Aerospace Research Institute

The Korea Aerospace Research Institute (KARI) utilizes the Large Thermal Vacuum Chamber (LTVC) for thermal vacuum testing of large satellite systems, such as Korea Multi-purpose Practical Satellite (KOMPSAT) series and Geostationary KOMPSAT (GK) series. After completing all preparations, satellites are moved into the LTVC for testing with lifting system. The lifting system, part of the satellite loading system, is used to move and install the satellite inside the chamber. An Approach Fixture (AF) is employed to access the satellite for final setup procedures.

Efficient thermal vacuum test setup operations require upgraded Lifting System Working Platforms and Approach Fixture Working Platforms to enable safe and smooth access to inside the chamber and the satellite. These upgrades allow work can be carried out more safely and efficiently.

In This paper, we describes the automation upgrade of the Lifting System Working Platform and the black anodizing surface treatment of the Approach Fixture Working Platform, which were implemented to improve the efficiency of thermal vacuum test setup operations. We present the progress and results of these efforts.

[P-34] Analysis of Dynamic Characteristics for a 2 m Head Expander for Satellite Vibration Testing

Jong-Min Im, Hee-Kwang Eun, Tae-Seok Oh

Korea Aerospace Research Institute

Ground-based vibration environmental testing is indispensable for verifying the structural integrity of satellites against dynamic loads encountered during launch. In vertical vibration tests for large satellites, a head expander is utilized as an extended interface to facilitate specimen installation and manage overturning moments.

This study investigates a head expander of 2 m diameter operated by the Korea Aerospace Research Institute (KARI) for vibration testing of specimens weighing up to 5 tons. To ensure high performance through weight reduction, the unit features a magnesium-welded structure and incorporates two central hydraulic bearings to control moments during testing.
As the head-expander is mechanically coupled with the test object, its dynamic characteristics significantly influence the interaction with the specimen and the overall vibration control performance. To identify these dynamic properties, modal testing and analysis were performed with the head-expander integrated into the vibration shaker system. Additionally, Operating Deflection Shape (ODS) analysis was conducted to precisely characterize the structural behavior under actual operational conditions. The findings of this study validate the dynamic reliability of the magnesium-welded head expander and provide critical baseline data for achieving vibration control in future large-scale satellite tests.

[P-35] Evaluation of IPA Reference Peak Deviations with Varying Relative Humidity in FT-IR-Based Satellite Molecular Contamination Measurements

Seungmo Hong, Sungwook Park, Gyumin Oh, Jihoon Choi

Korea Aerospace Research Institute

FT-IR spectroscopy is used to quantify trace molecular contamination that can affect satellite optical performance. In this study, isopropyl alcohol (IPA) deposited via chloroform solution was employed as a reference contaminant to investigate the effect of relative humidity on FT-IR measurement reproducibility. Under high-humidity conditions, a visible white residual layer formed on the sample surface after solvent evaporation, leading to increased scatter in IPA peak areas and degradation of repeatability. These results indicate that humidity control during sample preparation is essential for ensuring reliable quantitative FT-IR measurements of satellite molecular contamination.

[P-36] A Study on Measurement System Configuration for Satellite Acoustic Tests Using a Large Acoustic Chamber

Jin Park, Jongmin Lim, Namjin Moon, Seonje Jo

Korea Aerospace Research institute

Acoustic loads generated during satellite launch can significantly affect the structural integrity and electronic components of spacecraft. Therefore, acoustic testing on the ground is required to simulate and verify the launch acoustic environment prior to launch. In this study, the configuration of a measurement system used for satellite acoustic tests conducted in a large acoustic chamber is described. During the test, multiple microphones installed inside the chamber are used to measure the sound pressure level (SPL) and to verify whether the target acoustic test profile is satisfied. In addition, key measurement factors such as sensor placement and signal acquisition procedures are analyzed. The results of this study are expected to provide basic reference data for the configuration of measurement systems and verification of acoustic environments in satellite acoustic testing.

[P-37] Design and Implementation of a Control and Monitoring System for Orbit Environment Tests of Satellite System and Component

Heejun Seo, Sungwook Park, Jiseok Kim

Korea Aerospace Research Institute

To ensure the robust, continuous operation of multiple thermal vacuum and thermal cycling chambers for satellite testing, an integrated platform was developed based on a real-time database (RTDB). This system enhances availability and data integrity through a hot redundancy scheme between primary and backup servers, providing instantaneous failover to prevent control gaps. A centralized HMI consolidates monitoring and alarm management into a single workstation, optimizing operator efficiency. Reliability is further secured by automated pre-test verification of hardware and safety interlocks, minimizing human error. Additionally, integrated modules for asset history, calibration, and equipment inspection digitize the entire instrumentation lifecycle, supporting trend analysis and automated maintenance scheduling. This integrated model provides a standardized framework for space environment simulation, significantly improving operational efficiency, data consistency, and overall experimental reliability.

[P-38] CAP-C Payload Electrical Test Bed (ETB) Configuration of the CAS500-5 Satellite

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

Korea Aerospace Research Institute

CAP-C (Compact Advanced Payload with C band SAR Payload) is the payload of CAS500-5 satellite. The program objective of CAP-C payload is to develop C-band SAR hardware which provides 120 km of swath width and 10 meter resolution SAR water resources images. The main purpose of the payload ETB is to verify the electrical interface with the CAS500-5 satellite bus such as DC integration, connector pin assignment, power on and off status, command and telemetry compatibility, etc. In this paper, the payload ETB hardware configuration is presented, such as SAR Digital Unit (SDU) and RF Assembly

(RFA). Also, current status of SDU and RFA Electrical Ground Support Equipment (EGSE) is presented.

[P-39] Development of a Ground Test System for Intelligent Hazard Detection and Avoidance Technology during Lunar Lander Descent Landing

Sunyoup Park, Giwoong Lee, Jingi Ju,
Mincheol Shin, Min-Woo Kim, Dong-hwan Yoon
Satellite Technology And Research Center, IOPS Co., Ltd.

This study presents a preliminary research effort conducted prior to the development of a Korean autonomous lunar lander, proposing a plan for the development of a ground-based platform to pre-test and validate core Hazard Detection and Avoidance (HDA) algorithms. These algorithms are designed to perform landing site hazard detection and avoidance, safe zone identification, and autonomous landing missions based on artificial intelligence.

On the lunar surface, particularly in regions such as the polar areas or the far side where sufficient terrain information is not available, real-time direct control via communication with Earth-based control centers or centralized data server-based control is practically infeasible. Therefore, for unmanned autonomous landing missions, the system must independently recognize terrain, detect and avoid hazards, and select a safe landing site without external intervention. Such an independent decision-making and computational structure can be defined as an Edge AI-based autonomous system.

To ensure the reliability of intelligent autonomous landing algorithms, systematic validation in a ground environment is essential prior to deployment in actual lunar conditions. Accordingly, this study proposes a conceptual design of a ground test platform based on a quadcopter drone. The proposed platform is equipped with an onboard computing unit, the NVIDIA Jetson Orin NX, to perform autonomous decision-making, and is configured to conduct terrain recognition and hazard assessment through a multi-sensor fusion architecture incorporating optical cameras, LiDAR, and IMU sensors.

Through this test platform, it is expected that the real-time inference performance of the HDA algorithms, system stability under constrained computational resources, and autonomous landing success rates can be evaluated. Furthermore, the Edge AI-based autonomous decision-making algorithms developed in this study are anticipated to be applicable not only to future unmanned lunar landing missions but also to a wide range of autonomous system domains, including planetary exploration, disaster response, and unmanned operations in hazardous environments.

[P-40] Maintaining and Utilizing Frequency Resources in Geostationary Satellite Programs

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All satellites have limited operational lifetimes. When the lifetime of a satellite ends, satellites are deorbited, either by re-entry into Earth's atmosphere to burn up, or moved to a so-called graveyard orbit and powered down. This also applies to the satellite network that the relevant satellite was using. The satellite network may either be suppressed in case the satellite network is no longer to be used, or suspended if there are plans to continue use of the satellite network. If there are plans to continue use of the satellite network, either a replacement satellite must be readily available in the relevant orbit or there must be plans to launch and operate a replacement satellite at the same orbit within a given timeframe. This paper will look at the regulatory and technical aspects regarding the management of satellite networks in relation to the lifetime of geostationary satellites, aiming to provide knowledge and understanding in how to better maintain and utilize frequency resources in geostationary satellite programs.

[P-41] GUI Design for Baseband Electrical Ground Support Equipment

Seung-Won Cho, Yun-Goo Huh
Korea Aerospace Research Institute

Baseband Electrical Ground Support Equipment (EGSE) plays an important role in the Assembly, Integration, and Test (AIT) phase of satellite systems by enabling monitoring, control, and verification of communication subsystems. This paper presents the design and implementation of a graphical user interface (GUI) for baseband EGSE used in satellite communication subsystem testing. The developed GUI provides integrated functions including real-time monitoring and control of baseband EGSE equipment, status monitoring and control of modem devices, real-time telemetry updates, and event log display. These functions allow operators to easily monitor system status and efficiently perform control and verification during ground testing. In addition, the system records event logs and status information to support anomaly detection and troubleshooting during test operations. The proposed GUI improves operator efficiency and enhances the reliability of EGSE operation in satellite ground testing environments.

[P-42] A Software-Based Digital Delay Control Method for Stable Soft Start in Satellite Power Systems

Suwan Bang, Yungoo Huh
Korea Aerospace Research Institute

This paper proposes a software-based digital delay control

algorithm for voltage input to overcome the limitations of conventional fuse-based and analog methods in satellite power control systems. Unlike traditional hardware-centric approaches, the proposed method features a multi-stage voltage application process implemented through software. By controlling switching operations to generate intentional delays, this approach actively regulates the slew rate of the output voltage, thereby achieving a stable soft start. This method not only simplifies complex analog circuitry but also enables precise voltage output control tailored to specific operating environments, ultimately enhancing the reliability of power supply systems in satellites.

[P-43] Improving Configuration Change Management for GEO Satellite Development: A CCR-CCP Process Perspective

Chul Kang

Korea Aerospace Research Institute +

Satellite development is characterized by long development cycles and high system complexity, which makes configuration management an essential process for effectively controlling design changes. In particular, geostationary public multipurpose communication satellite development programs consist of numerous subsystems and complex interfaces, requiring systematic management of configuration changes throughout the development lifecycle. In this context, the procedures of Configuration Change Request (CCR) and Configuration Control Panel (CCP) serve as key change management processes responsible for reviewing change requests, conducting impact analyses, and supporting approval decisions.

This study analyzes the configuration change management framework focusing on the CCR–CCP procedures applied in geostationary public multipurpose communication satellite development programs and examines their operational characteristics and limitations. To achieve this, the overall change management process in satellite development projects was investigated, including change request submission, technical review, impact assessment, and final approval by the Configuration Control Board (CCB). Furthermore, several practical challenges observed in satellite development environments were identified, such as delays in change approval, limitations in cross-system impact analysis, and insufficient utilization of digital configuration management tools.

To address these issues, this study proposes an improved change management approach that incorporates risk-based change classification, integrated impact analysis procedures, and digital configuration management support. The proposed approach aims to enhance the efficiency of decision-making in configuration change control and strengthen traceability and management of configuration changes. The results of this study are expected to contribute to improving configuration change management procedures in future satellite development programs and to support the establishment of more systematic configuration management practices in space system development.

[P-44] An Introduction to Anti-Jamming Techinques for Satellites

Won-Gyu Lim, Ki-Ho Kwon, Joong-Pyo Kim, Sun-Ik Lee

Korea Aerospace Research Institute

In this paper, we investigate and analyze the RF front-end structure in the Satellite. RF front-end means antenna, transponder and RF passive path to connect them. This paper mainly focused the RF passive path rather than antenna or transponder. According to the investigation and analysis about the structure, the LEO and GEO mission use the hybrid coupler type in the front-end in which mission have enough communication link margin and so the mission select to receive/transmit via all antenna. Compare to them, the deep space mission prefer to select the communication path, especially for transmit the signal. The reason to use the switch is that the communication link margin is not enough. In this paper, we present the rational to select the structure according to the mission.

[P-45] A Survey of Orbit Families for Lunar Navigation Satellite Systems: Trade-offs and Design Strategies

Chaerin Jeong[1], Jiwon Lee[1], Minseok Kim[1], Young-Joo Song[1,2]

[1] *G-LAMP NEXUS Institute / School of Space Research, Kyung Hee University*

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

Recently, growing international interest in lunar exploration has emphasized the need for reliable Lunar Navigation Satellite System (LNSS). The LNSS must provide integrated services that include navigation support for lunar surface missions, communication visibility for specific regions such as the lunar poles, and navigation coverage throughout the cislunar region. Despite numerous LNSS design studies, systematic comparisons among different constellation architectures remain limited because each study adopts distinct design objectives and underlying philosophies. To address this, existing studies are systematically classified into four orbit families: lunar-centered orbits, libration-point orbits, distant retrograde orbits, and hybrid constellations. For each family, key parameters—including service coverage (global lunar surface, polar regions, and cislunar space), required number of satellites, navigation performance metrics (visible satellite count, Dilution of Precision (DOP), and positioning accuracy), orbital stability, and system complexity—are compared to identify trade-offs between design

characteristics and performance. The results show that lunar-centered orbit constellations provide high surface coverage and strong navigation performance but require a relatively large number of satellites. Libration-point and distant retrograde orbit constellations offer communication service across cislunar space with fewer satellites, although their surface-level service availability and uniformity are limited. Hybrid constellations combine multiple orbit types to balance satellite count, coverage, and service availability, at the cost of increased system complexity. These comparative analyses clarify the relationships among orbit type, service area, and number of required satellites, providing practical insights for selecting suitable constellation strategies. Furthermore, this survey is expected to provide a systematic reference for future international collaboration and to facilitate potential participation in global lunar navigation infrastructure development.

[P-46] A Python-Based Quality Issue Management Automation System to Support Aerospace PA Activities

CheolSu Shin, Guen-Young Park, JoongPyo Kim
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In aerospace development programs, Product Assurance (PA) activities play a critical role in maintaining system reliability and safety. Quality issues are typically reviewed through technical boards such as MRB, PMPCB, and CCB. However, many tasks related to issue tracking, agenda preparation, and meeting minutes documentation are still performed manually using spreadsheets or documents.
This study proposes a Python-based automation system for managing quality issues in aerospace PA activities. The proposed system supports issue registration, board agenda generation, meeting minutes documentation, and issue history tracking. The system is expected to improve documentation consistency and support more systematic management of quality issues.

[P-47] Definition of Satellite Electrical Test Configuration and Health Check Procedure during Launch Campaign

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During the satellite launch preparation process (Launch Campaign), the satellite undergoes several operational phases, including transportation to the launch site, propellant loading, co-passenger integration, payload encapsulation, and launch vehicle integration. Throughout these activities, the operational configuration of the satellite continuously changes.
Such configuration changes may affect the electrical status of the satellite system; therefore, electrical testing and monitoring procedures are required at each stage of the launch preparation process to verify the satellite health status. In particular, after payload encapsulation, physical access to the satellite becomes restricted, and satellite status verification must be performed through limited interfaces.
Based on launch campaign experience using commercial launch services, this study summarizes the definition of satellite electrical test configurations and health check procedures during the launch campaign. The study describes satellite health verification methods and electrical status check procedures that can be performed at each stage of the launch preparation process, and also presents satellite monitoring procedures during the launch countdown phase. In addition, operational considerations during launch site operations are discussed, including preparation of test harnesses, management of test procedures, cable interface verification, and backup operation of electrical ground support equipment (EGSE).

[P-48] Analysis of CubeSat Contest Performance and Improvement Strategy Using Antarctic Ground Stations

Sungwon Seo
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This study analyzes the mission performance of CubeSats developed through the Korean CubeSat Contest and launched between 2012 and 2025. Although most satellites successfully reached orbit, the overall mission completion rate remains limited due to factors such as insufficient communication opportunities, early operational instability, and limited ground contact windows. Analysis of the operational results of 19 CubeSats indicates that restricted communication passes during the early mission phase significantly affected telemetry reception, command transmission, and payload operation.
To address this issue, this study proposes the expansion of ground communication infrastructure through the installation of an Antarctic ground station antenna. A polar ground station can significantly increase contact opportunities for low Earth orbit CubeSats, particularly those in sun-synchronous or near-polar orbits, thereby increasing cumulative communication time. Improved communication availability enables faster anomaly detection, more reliable command uplink, and enhanced data acquisition, ultimately contributing to improved operational stability and higher mission success rates for university-led CubeSat programs.

[P-49] Star Tracker Visibility Analysis of LEO Satellite during Ground-Target Pointing Maneuvers

Hwayeong Kim, Jeonghoon Hyun, Kyunsang Park,

Day-young Kim

Korea Aerospace Research Institute

This paper presents a visibility analysis of star trackers during mission operations where a Low Earth Orbit (LEO) satellite is oriented toward specific ground targets. While star trackers provide high-precision attitude information, light interference from the Sun or Earth during mission maneuvers can degrade attitude determination accuracy. In this paper, external light interference within the optical heads of star tracker were analyzed based on attitude maneuver scenarios performed by the satellite to point at specific targets on the ground. Detailed analyses were conducted for a total of three cases, with target points located both domestically and internationally. The analysis results revealed that in one of the cases, during specific intervals of target pointing and maneuvering, the Sun and Earth entered the unobstructed field of view (FOV) of certain star tracker units, leading to degraded visibility. These findings confirm that attitude changes required for target orientation during mission operations can induce performance degradation in star tracker units. The results of this study are expected to serve as a basis for establishing operational strategies to minimize image quality degradation caused by visibility loss during the satellite's mission phase.

[P-50] Conceptual Design of an Environmental Control System for an Uncrewed LEO Space Station

Younkyu Kim, Joohee Lee, Choonwoo Lee

Korea Aerospace Research Institute

This study investigates the requirements and key design considerations of the Environmental Control and Life Support System (ECLSS) for an uncrewed space station operating in low Earth orbit (LEO) to support multidisciplinary mission activities. In general, the ECLSS of a crewed space station includes various subsystems such as air revitalization, pressure control, temperature and humidity control, water management, and waste management to maintain a habitable environment for astronauts. However, since an uncrewed space station does not accommodate crew members, the system architecture can be significantly simplified. In such cases, the ECLSS primarily focuses on maintaining structural integrity and environmental stability through pressure control, temperature and humidity regulation, and safety monitoring. In this study, the technology status and system concepts of ECLSS were analyzed through case studies of uncrewed cargo spacecraft, including the ATV developed by ESA and the HTV developed by JAXA. Based on these analyses, the functional requirements and design considerations for pressure control and thermal-humidity control systems applicable to an uncrewed space station were derived. Furthermore, a conceptual design of the environmental control system was developed for a pressurized module with an internal volume of approximately 20 m^3. Finally, an operational scenario for the proposed uncrewed space station was suggested based on the conceptual ECLSS architecture.

[P-51] Mechanical System Analysis of Overseas Geostationary Satellite Development: Cases of QZSS and GSAT-11

Jongwon Lee

Korea Aerospace Research Institute

As geostationary satellite systems become larger and more complex, mechanical system design plays a critical role in ensuring structural integrity, mass efficiency, and reliable long-term operation. This study reviews overseas satellite development cases and analyzes key mechanical system elements, focusing on mass characteristics and structural configuration.

The study examines Japan's Quasi-Zenith Satellite System (QZSS) and India's GSAT-11 as representative cases. QZSS was developed to enhance satellite navigation coverage and positioning performance over Japan and surrounding regions. Publicly available information indicates that QZS-3, a geostationary satellite in the QZSS program, had a launch mass of about 4,700 kg, including approximately 475 kg of payload and about 1,210 kg of satellite bus mass. GSAT-11, developed by ISRO, is a large geostationary communication satellite based on the I-6K bus, with a launch mass of approximately 5,854 kg, a mission life of 15 years, and power generation of 13.6 kW. Based on these two cases, this study discusses major mechanical system considerations for large geostationary-class satellites, including structural design under launch loads, mass budgeting, and payload-bus integration. Although QZSS and GSAT-11 differ in mission purpose, both cases show that mass planning and structural configuration are fundamental factors in overall satellite system design. This study is expected to provide practical reference data for the preliminary design and systems-level trade-off analysis of future geostationary satellite platforms.

[P-52] Key Design Concepts for KPLL Mechanical Systems

Seung Yong Min, Eui-Keun Kim

Korea Aerospace Research Institute

Korea Pathfinder Lunar Lander (KPLL) is currently being developed with a target launch in 2032. KPLL has a total mass of approximately 1,800 kg and will be launched by KSLV-III. The mechanical systems and configuration design of KPLL is being conducted based on several key design concepts. These key design concepts include modular design and structural architecture, propulsion system configuration, landing gear

geometry, solar array and avionics unit layout. Rover and payload accommodation is also under review. In this paper, key design concepts for KPLL mechanical systems are summarized. Rover and payload accommodation plan is also presented.

[P-53] Analysis of Atomic Oxygen Environment and Erosion Effects on Spacecraft Materials in Very Low Earth Orbit (VLEO)

Kyungjin Kwon, Bonggu Jeong

Korea Aerospace Research Institute

Very Low Earth Orbit (VLEO) satellites operate at relatively low altitudes close to the Earth's surface, offering advantages such as ultra-high-resolution Earth observation and low-latency communication. However, in such environments, increased atmospheric density leads to significantly higher atomic oxygen (AO) flux, which has a critical impact on the degradation and erosion of spacecraft exterior materials.
In this study, the atomic oxygen environment in VLEO was analyzed using the Space Environment Information System (SPENVIS). The variation of AO flux and cumulative fluence with orbital altitude was evaluated, and the resulting erosion depth of representative spacecraft materials was estimated.
The results indicate that AO exposure increases rapidly as orbital altitude decreases, resulting in significantly higher material erosion in lower altitude regimes. These findings suggest that AO-induced material degradation should be carefully considered in the design of VLEO spacecraft.

[P-54] A Study on the Electromagnetic Compatibility (EMC) Verification of Nanosatellite

Taeyoun Kim, Jaewoong Jang, Kyungduk Jang, Sangrok Lee, Changeun Lee, Insang Yu

Korea Aerospace Research Institute

The development of small satellites has recently become a significant part of the space industry. Coupled with advancements in launch vehicle technology, the trend toward satellite miniaturization is enhancing satellite utility in various forms across both public and private sectors. Nanosatellites are primarily built with standardized modular structures and often incorporate commercial off-the-shelf (COTS) components within constrained spaces, which can lead to critical system level Electromagnetic Compatibility (EMC) risks. However, cost-reduction pressures limit iterative validation through testing, and the structural characteristics of nanosatellites (particularly CubeSats) pose challenges in applying conventional EMC verification requirements. This paper aims to briefly introduce EMC design and verification requirements for nanosatellites by analyzing relevant guiding documents and previous research.

[P-55] Management Framework for Multi-Ministerial R&D Programs in IRIS

Jimo Yang

Korea Aerospace Research Institute

Multi-ministerial R&D programs fall under national R&D projects and are therefore subject to the Integrated R&D Support System (IRIS). However, due to the absence of specific operational and management regulations for multi-ministerial R&D programs under the Innovation Act, each ministry and specialized agency has applied different standards in practice. This has resulted in difficulties, as such programs have had to be managed in a manner similar to single-ministry projects.
To address these issues, common management standards for multi-ministerial R&D programs were established to enable their systematic management within IRIS. In addition, differing practices across ministries and specialized agencies—such as budget account management and authority management—were functionally modularized. This paper examines the development of these modules and their implementation as an actual management program within IRIS.

[P-56] Design and Manufacture of a Clip-Type Small Radiator Plate and Analysis of Temperature Distribution

KyuMin Oh, SunKi Baek, Sung-Wook Park, KeunShik Kim, Hee-Jun Seo, Ji-Seok Kim, Ji-Hoon Choi, SeungMo Hong

Korea Aerospace Research Institute

Thermal control technology, which precisely controls the temperature of specimens, is crucial when testing satellite and space components due to their operation in extremely low-temperature environments. Thermal Vacuum Tests utilize various thermal control devices and methods for this purpose. This study measured and analyzed the thermal changes and surface temperature distribution of radiator plates fabricated using different methods.
Typically, radiator plates are made using copper plates to ensure high thermal conductivity. They are fabricated by brazing liquid nitrogen pipes to the plate. While this method offers excellent thermal conductivity, it has drawbacks such as a complex fabrication process, shape distortion due to thermal deformation during manufacturing, and high maintenance costs.
In this test, a clip-based structure was adopted to fabricate a small-sized radiator plate as an alternative to the conventional brazing method. The clip method offers advantages such as a relatively simple fabrication process and ease of structural modification and maintenance. However, the contact between the liquid nitrogen pipes and the thermal control plate may not be as perfect as with brazing, potentially leading to reduced heat

transfer performance.
Therefore, this research measured the surface temperature distribution and analyzed the thermal characteristics of the radiator plate fabricated using the clip method. A subsequent study will compare it with the brazing method.

[P-57] Cosmic Ray Variations Observed by the Mt. Gamak Neutron Monitor from July 2024 to March 2026

Jongil Jung[1], Young-Sil Kwak[1,2], Jongdae Sohn[1], Suyeon Oh[3], Yu Yi[4], Tae-Yong Yang[1]

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[3]*Chungnam National University*
[4]*Chonnam National University*

Neutron monitors (NMs) are the ground-based instruments that measure secondary neutrons produced by primary cosmic rays entering the terrestrial atmosphere interacting with atmospheric nuclei. Generally, NMs are sensitive to cosmic ray energies ranging from approximately 500 MeV to several GeV, which is essential for studying solar activities and galactic cosmic ray variations. The representative phenomena of cosmic ray variations include ground level enhancement (GLE) and Forbush decrease (FD). The Geochang Mt. Gamak NM has been operated since 2024. In the previous presentation, we provided a detailed introduction to the installation process, system configuration, and basic data processing of Geochang Mt. Gamak NM. In this presentation, we aim to present the entire variation characteristics of the count rate based on observation data accumulated from July 2024 to March 2026. Additionally, we will discuss the re-evaluated results of basic processing and the responses observed during major space environment events.

[P-58] Design and Development of a Memory Housing for Space Radiation Hardness Testing

Hojin Lee[1,2], Sanghun Song[1], Jihye Baek[1], Kyohoon Ahn[1,2]

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Satellites operating in the space environment are exposed to space radiation. Space radiation can be broadly classified into solar cosmic rays and galactic cosmic rays. Electronic components exposed to space radiation are subject to various effects, including Total Ionizing Dose (TID) and Single Event Effects (SEE). TID is a time-dependent effect, referring to the process where electronic components absorb radiation energy and become ionized. SEE is a probabilistic effect, referring to the various processes that occur when radiation particles physically and electrically interact with electronic components.
This study introduces the design and development of a housing for memory demonstration testing focused on TID. The housing is intended to be mounted on a CubeSat and is designed in a 1U (100 mm × 100 mm × 100 mm) form factor. It is configured to assemble a total of five PCBs and one backplane, accommodating four memory modules. Based on this design, simulations were conducted using the Monte Carlo-based radiation simulation programs Geant4 (GEometry ANd Tracking) and MCNP6 (Monte Carlo N-Particle Transport Code).

[P-59] Global Simulation for Exoplanet Magnetosphere

Kyung Sun Park[1], Satoshi Masuda[2], Kanako Seki[3], Jongchul Chae[4], Yoshizumi Miyoshi[2], Fukazawa Keiichiro[5]

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We performed a global MHD simulation of the magnetospheric dynamics of an exoplanet under purely northward and southward interplanetary magnetic field (IMF) conditions. The simulation conditions as input parameters are a solar wind speed of 700 km/s, a number density of 300 /cc, and an IMF strength of 30 nT. The simulation box size is (nx, ny, nz) = (500, 300, 300) with a grid spacing of 0.3 R_{ex}. We assume an ionosphere density of $\sim 10^{11} m^{-3}$, and the surface magnetic field strength at the equator to be that of Earth. The simulation results show new insights into early environmental conditions and the complex magnetospheric dynamics driven by a global magnetic field and a strong solar wind.

[P-60] Investigation of the Technique of Measuring the Martian Meridian Using a Sundial

Byeong-Hee Mihn[1,2,3], Sang Hyuk Kim[1], Jiwon Park[2,4], Jeong-Yeol Han[1,3], Gyeong-Han Yoo[2,4]

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[3]*Korea University of Science and Technology*
[4]*Chungbuk Pro Maker Center*

During the Joseon Dynasty, King Sejong developed the Jeongnam-Ilgu, a specialized sundial designed to determine the meridian (due south). Beyond their traditional role in timekeeping, sundials serve a critical function in identifying the meridian line. This principle is currently applied in Mars exploration to establish orientation and celestial directions. Notables examples

include the calibration target for the Curiosity Mastcam and Perseverance Mastcam-Z, as well as the the InSight sundial. These missions employ horizontal sundia mechanisms to achieve sub-degree accuracy by tracking the gnomon's shadow. This presentation reviews these precedents and intorduces advanced georeferencing methods based in these principles.

[P-61] Science Mission Concept for Korea's Future Mars Exploration through International Collaboration

Joo Hyeon Kim

Korea Aerospace Research Institute

South Korea has established plans to launch a Mars orbiter in 2035 and a Mars lander in 2045 through the 4th Basic Plan for the Promotion of Space Development (Revised Plan) and the Space Science Exploration Roadmap, and has announced that preliminary planning studies for these missions will begin in 2025. For these plans to be developed into actual exploration missions, it is necessary to define scientific goals and science missions in advance, together with the development of the required technologies. In planetary exploration, scientific goals are key elements that determine mission scenarios, and therefore the selection of science missions and the corresponding conceptual studies are essential. Although South Korea has successfully operated five scientific payloads on the Danuri lunar orbiter, its experience in space missions has so far been largely limited to the Earth-Moon system.

Recent lunar exploration programs in Korea and other countries include scientific objectives, but in many cases they are mainly focused on practical purposes such as in-situ resource utilization (ISRU), crewed and uncrewed lunar base construction, technology demonstration, and the realization of the space economy. In contrast, deep-space planetary exploration, including Mars exploration, is still mainly centered on scientific research. In fact, many planetary missions conducted or planned by leading spacefaring nations have been formulated on the basis of scientific questions, goals, and objectives. Therefore, if South Korea is to pursue Mars exploration in earnest, it is necessary not only to develop the required technologies but also to propose science missions and carry out sufficient conceptual studies for them.

In addition, planetary exploration generally requires long development periods, large budgets, and high technical complexity, and for this reason many missions in the United States and Europe have been pursued through international cooperation. Although South Korea ultimately aims to secure independent planetary exploration capabilities, it would be realistic and effective in the early stage to actively pursue international cooperation. Accordingly, conceptual studies are needed to establish the goals, objectives, and mission scenarios of science missions applicable both to an independent Mars mission and to Mars exploration through international cooperation. In this presentation, we propose a science mission concept applicable to both independent and internationally cooperative Mars exploration within South Korea's future Mars exploration program, and present its scientific goals, objectives, and conceptual framework.

[P-62] Feasibility Study of an Autonomous Safe Landing System for Planetary Missions

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As NASA shifts priority to the ground and pauses Lunar Gateway for the time being, the demand for autonomous Entry, Descent, and Landing (EDL) systems has become crucial. This study proposes an autonomous integrated Guidance, Navigation, and Control (GNC) system designed for fuel-optimal EDL maneuvers, addressing the technical challenges of increasing landed mass and ensuring high precision under atmospheric constraints. To achieve fuel efficiency, this research presents semi-analytical solutions for optimal control problems in 3-dimensional planetary landing trajectories. By transforming the problem into a Hamiltonian canonical system through first-order optimality conditions, the study identifies feasible extremal trajectories. These solutions allow for a precise description of the state vector and Lagrange multipliers, facilitating the determination of the number and sequence of thrust arcs. Additionally, new extremal trajectories were derived by analyzing second-order optimality conditions, providing a robust framework for mission design and trajectory synthesis. And the proposed GNC system integrates an Extended Kalman Filter (EKF) for navigation state estimation with E-guidance functions to show a possibility of a safe landing. Simulation results show the feasibility of the integrated system, demonstrating its ability to perform precise EDL maneuvers. These findings offer a versatile framework adaptable to various celestial bodies where central gravity dominates, serving as a foundational technology for next-generation autonomous landing missions.

[P-63] Thermal Design of Warm Electronic Box (WEB) for Efficient Thermal Management of Spacecraft

Hui-Kyung Kim[1,2]

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[2]*University of Science and Technology*

In deep space missions where solar power is insufficient due to extreme environmental conditions, thermal control approach focuses on minimizing heat loss and utilizing alternative energy sources. To reduce the power consumption of spacecraft,

Radioisotope Heating Units (RHUs) instead of conventional electrical heaters are employed as constant thermal sources from the half-life of radioisotope. Unlike standard heaters that operate via On/Off control within specific temperature ranges, RHUs provide continuous thermal heating and are treated as constant heat sources in thermal design. For planetary exploration probes on the Moon or Mars, a Warm Electronic Box (WEB) is typically implemented to enhance thermal management efficiency. The WEB integrates most electronic components within a single insulated enclosure to facilitate mutual heat sharing and minimize total thermal power. Consequently, the internal layout design of the WEB is critical for effective thermal management. This study presents a conceptual design of the WEB through thermal analysis of the WEB equipped with RHUs, specifically focusing on the survival of a lunar lander operating in the South Pole—the most extreme low temperature environment during the lunar night.

[P-64] Development and Validation of Mechanism Attitude C-Kernels for the Danuri (KPLO) Solar Arrays and High-Gain Antenna

Seunghee Son

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, includes several spacecraft mechanisms whose orientations vary during mission operations, including the solar arrays and the high-gain antenna (HGA). Accurate modeling of these time-varying mechanism attitudes is essential for spacecraft operations, geometry calculations, antenna pointing analysis, and scientific observation planning. This study presents the development and validation of mechanism attitude C-kernels (CK) for the solar arrays and HGA of Danuri using the NASA SPICE toolkit. Mechanism orientation information derived from spacecraft telemetry and operational attitude data is converted into time-tagged quaternion or Euler-angle representations and stored in CK format to describe the dynamic orientations of these components relative to the spacecraft reference frame. The generated CK kernels enable precise reconstruction of the mechanism attitudes throughout mission operations. Validation of the generated kernels is performed through comparisons with mechanism telemetry and geometry verification using SPICE-based analysis tools. Results demonstrate that the generated CK kernels accurately represent the mechanism pointing behavior and support reliable spacecraft geometry computations. The proposed approach provides an effective framework for modeling time-varying spacecraft mechanisms and supports operational and scientific analysis for the Danuri mission.

[P-65] Ground Stations as External Reference Providers for Navigation in Lunar and Mars Exploration

Lammi Choi, Min-A Kim

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Future lunar and Mars exploration missions require sustained navigation performance in environments where Global Navigation Satellite Systems (GNSS) are unavailable. Although onboard autonomous navigation provides the primary means of spacecraft state estimation, long-duration missions inevitably face accumulated errors and drift, highlighting the importance of external observational support in deep-space environments. Ground stations have traditionally been regarded as infrastructure for telemetry, tracking, and command (TT&C). However, in deep-space missions, their fundamental contribution lies in generating and providing tracking observations that enable navigation processes such as orbit determination and state estimation. For instance, the NASA Deep Space Network supplies ranging and Doppler tracking data that serve as essential inputs for navigation analysis. In Korea, operational experience from lunar exploration missions conducted by the Korea Aerospace Research Institute (KARI) has also demonstrated the significance of ground-based tracking infrastructure in supporting deep-space operations. This study highlights the role of ground stations as providers of observational support that enhance navigation reliability in GNSS-denied environments. By examining the structural significance of ground-based tracking data, the study discusses how ground stations enable orbit determination and state estimation, thereby contributing to long-term navigation stability in future lunar and Mars exploration missions.

[P-66] Analysis of Operational Performance Indicators for Channel-to-Channel Registration (CCR) of GK2A AMI Water Vapor Channel Images

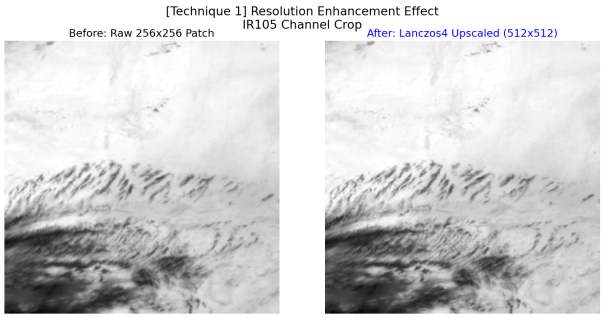
Junho Kim

National Meteorological Satellite Center

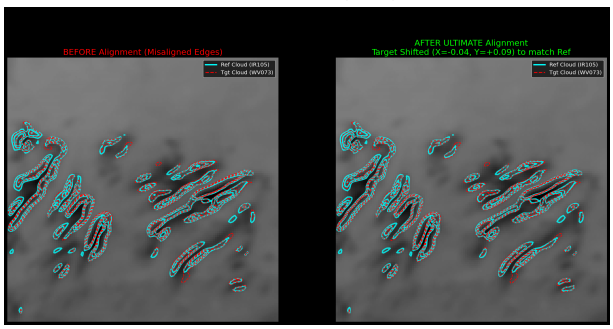
This analysis presents an Artificial Intelligence (AI)-based approach for Channel-to-Channel Registration (CCR) of GEO-KOMPSAT-2A (GK2A) Advanced Meteorological Imager (AMI) Level 1B water vapor channel images for ground system operational performance and quality monitoring.
Water vapor channel image is one of the key input data for Numerical Weather Prediction model, and the performance of inter-channel registration is very important. However, conventional methods are fundamentally limited, as the intrinsic characteristics of water vapor channels make it difficult to extract reliable landmark features for precise image matching. To address these challenges, we propose a CPU-optimized approach that integrates the following AI-based techniques.
First, Efficient Sub-Pixel Convolutional Neural Network (ESPCN),

which upscales image resolution to enhance cloud masking performance and improve the accuracy of the image matching algorithm. Second, Enhanced Correlation Coefficient (ECC), which serves as an alignment engine to determine the optimal X and Y translation shifts where cloud patches in the reference and target channels are best aligned. It can accurately detect registration errors based on structural similarity, even when absolute pixel intensities differ between channels. Finally, Density-Based Spatial Clustering of Applications with Noise (DBSCAN), which used for error or mismatched data filtering. By extracted data with a matching confidence score of 0.8 or higher, we confirmed an average registration accuracy within 0.3 pixels (equivalent to 0.6 km, given a spatial resolution of 2 km per pixel).

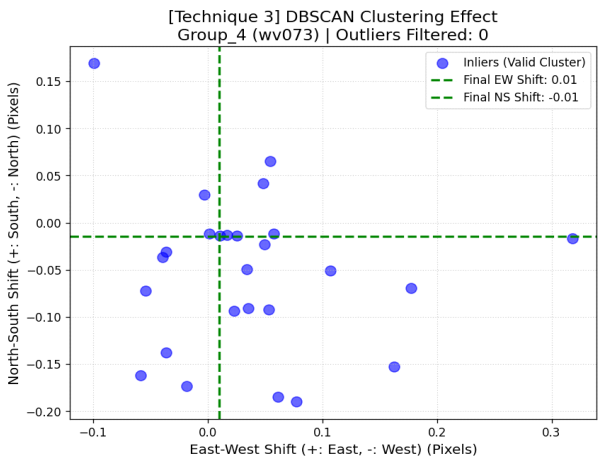
Efficient Sub-Pixel Convolutional Neural Network (ESPCN)

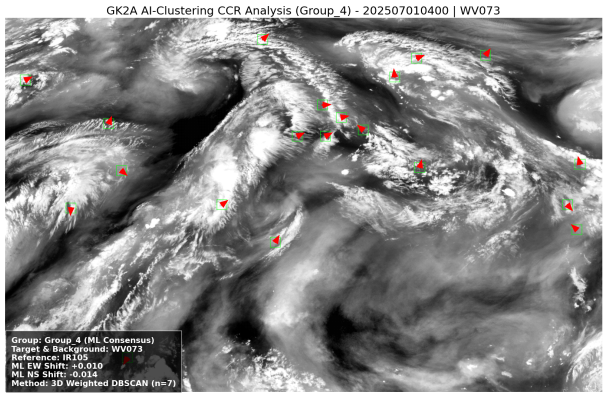


Enhanced Correlation Coefficient (ECC)



Result





[P-67] A Study on Technical Support Approaches for Enhancing Satellite Operations

Kyunsang Park, Jeonghoon Hyun

Korea Aerospace Research Institute

Efficient satellite operations require continuous technical support to reduce operator workload and improve operational efficiency. In satellite ground operations, many routine tasks such as monitoring telemetry, preparing command sequences, and managing operational data are repeatedly performed by operators. This study examines several operational tasks that can be partially automated to assist operators and improve operational efficiency. Based on practical satellite operation experience, several technical support approaches are proposed for routine monitoring, command preparation, and operational data handling. The study discusses how these approaches can help streamline operational procedures and contribute to more efficient and stable satellite mission operations.

[P-68] Analysis of Operational Architecture and Requirements for Automated Imaging Planning in Multi-Satellite Constellations

Jeonghoon Hyun, Kyunsang Park

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The rapid expansion of Earth observation (EO) constellations has shifted the operational focus from single-satellite management to the high-efficiency coordination of multi-satellite systems. This study investigates the systemic architecture and functional requirements of Mission Planning Systems (MPS), with a specific emphasis on imaging task optimization. Unlike conventional planning, modern imaging missions require complex trade-offs between various constraints, including power budgets, onboard storage, agile slewing capabilities, and dynamic environmental conditions.

This paper analyzes the transition from centralized, human-in-the-loop scheduling to distributed and automated architectures.

By reviewing global development trends, we identify key architectural components such as priority-based conflict resolution and real-time mission re-planning for urgent targets. Furthermore, this study derives a set of core functional requirements for a generalized imaging planning platform. The findings provide a technical foundation for developing scalable ground-segment solutions that maximize data acquisition efficiency and operational autonomy in multi-satellite environments.

[P-69] The Trend Analysis in PVSAT Bus Subsystem Performance in Normal Operation Phase

Sangil Ahn[1], Rho-Sun Park[2], Seung-Beom Bae[2]

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The PVSAT, launched as the main payload on June 22, 2026, at Nuri-II launch successfully launched for 2 years after initial check-out and is currently carrying out additional mission.
In order to ensure the successful operation of the mission during the initial satellite body design, the design was carried out mainly in consideration of stability in hardware design along with logic design for fault management in case of failure, but the cost was also considered when selecting parts, so interest in the operational stability and performance changes of the main subsystem of the PVSAT was high for more than three years after launch.
As a result, a trend analysis of EPS, AOCS, Communication Subsystem and space environmental impact was conducted for about 3.5 years after launch, confirming that all subsystems have been operating well within the expected ranges since launch. The performance trend of major subsystems is shown in this paper.

[P-70] Enhancement of Satellite Tracking Accuracy for Ground Antenna Systems via Atmospheric Refraction Compensation

Hyungmo Yang, Jungwon Seo, Changyoon Song

Korea Aerospace Research Institute

Ground antennas for satellite tracking typically calculate tracking profiles using internal ACU (Antenna Control Unit) algorithms based on provided TLE (Two-Line Element) data. The Antenna system utilizes the SGP4 algorithm and PID servo control to follow these calculated profiles.
In analyzing tracking accuracy, a comparative study is performed between the command data-generated by the ACU unit based on the TLE-and the actual data recorded during operation. Various tracking errors occur during this process; notably, errors induced by the atmospheric refractive index. This paper proposes a methodology to improve antenna tracking accuracy by analyzing and compensating for these atmospheric refraction effects.

[P-71] Performance Analysis of Tracking Accuracy based on the Drive Velocity of Ground Antenna Systems

Changyoon Song, Hyungmo Yang, Jungwon Seo

Korea Aerospace Research Institute

Ground antenna for satellite tracking are typically composed of Azimuth (AZ), Elevation (EL), and 3rd-axis configurations. The types of satellites that can be tracked are fundamentally limited by the antenna velocity (angular speed) of each axis. While the drive mechanisms for the AZ and EL axes are generally standardized across most antenna systems, the implementation of the 3rd-axis varies significantly among manufacturers. Consequently, these architectural differences lead to variations in maximum tracking velocity and constraints on trackable satellite orbits.
This paper presents a performance analysis of tracking accuracy based on the operational mechanisms and velocity differentials of the AZ, EL, and 3rd-axis components, specifically utilizing the Safran Vision730 antenna as the reference system. The results describe the degree to which tracking precision is influenced by the drive characteristics of each respective axis.

[P-72] Survey of Learning Approaches for Introducing Large Language Models into Secure Satellite Operation Environments

Jaehyoung Park, Hyunchang Lee, Jungsik Choi, Hyunchul Baek, Hyung Mo Yang

Korea Aerospace Research Institute

Recent progress in large language models (LLMs) has opened new possibilities for supporting complex operational tasks in engineering systems. In the field of satellite operations, LLM-based technologies may assist operators in tasks such as telemetry interpretation, anomaly investigation, mission planning support, and operational knowledge retrieval. However, applying these models to real satellite ground systems is not straightforward because many operational environments are deployed in isolated or restricted networks where external connectivity and large-scale cloud-based training are limited. This paper reviews potential learning approaches for introducing LLM capabilities into secure satellite operation environments. In particular, two practical directions are examined. The first approach considers federated and distributed learning techniques, where model parameters are updated collaboratively while sensitive operational data remain within each secure network.

The second approach focuses on the use of externally pre-trained foundation models that are adapted within secure environments using techniques such as retrieval-augmented generation (RAG) and parameter-efficient fine-tuning. Based on these approaches, this survey discusses possible system architectures and operational scenarios for LLM-assisted satellite operations, including telemetry analysis, anomaly response support, and satellite imagery metadata search. The objective of this study is to provide an overview of feasible technical options and to highlight key considerations when introducing LLM technologies into secure satellite operation infrastructures.

[P-73] A Method for Ground Station Integrity Verification Based on Satellite Reception Results

Gyeoul Lee, Hyeongmo Yang, Hyunchul Baek

Korea Aerospace Research Institute

Satellite ground stations play a critical role in ensuring reliable reception and utilization of Earth observation data. However, in many operational environments, satellite reception results are primarily used to confirm data delivery, and systematic methods for verifying the integrity of ground stations based on reception outcomes are limited. As a result, it is often difficult to promptly identify anomalies occurring across the ground reception chain, including antennas, RF reception systems, demodulators, and ground data processing systems.

In particular, conventional operational practices tend to assess system status mainly based on reception success, which makes it difficult to detect reception quality degradation or early signs of system anomalies. To address this limitation, this paper proposes a ground station integrity verification method based on reception quality indicators rather than simple reception success.

The proposed method analyzes reception data generated during satellite passes, including CADU (Channel Access Data Unit) frame synchronization markers and signal quality metrics such as Eb/N0, to evaluate the operational status of the ground reception chain. By integrating frame synchronization status and signal quality information, the method derives integrity indicators representing the reliability of the reception process.

The proposed method was applied to an operational satellite ground station environment, where reception data from multiple satellite passes were analyzed. The results demonstrate that the method can effectively distinguish between normal and abnormal reception conditions and provide a systematic approach for verifying ground station integrity.

The proposed approach can be utilized for satellite reception performance monitoring and anomaly detection in ground stations. Furthermore, by analyzing data anomalies under conditions where the reception link and ground station integrity are ensured, the method can also support the identification of potential anomalies in satellite payload operations.

[P-74] Emerging Cyber Threats in Space Systems

Eungsik Park, Sunghyun Woo

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In recent years, space systems have become critical infrastructure supporting national security and economic activities through services such as communications, navigation, and Earth observation. As their importance grows, they are increasingly considered potential targets for cyber threats. However, based on publicly available information, documented cyberattacks that directly target space systems themselves remain relatively limited. Most reported incidents to date have primarily targeted end user segments, including user terminals, ground networks, and service infrastructure, rather than the satellites themselves. Nevertheless, several countries (including the United States, Russia, China, and France) are known to possess both the capability and willingness to conduct offensive cyber operations against non-space targets. This suggests that such capabilities could potentially be extended to the space domain.

Furthermore, the technological barriers to conducting cyber operations against space systems are gradually decreasing. The rapid expansion of commercial satellite systems and the growth of the private space industry have introduced a larger number of systems with relatively weak cybersecurity protections. As a result, even non-state actors without direct state sponsorship may potentially acquire the capability to conduct limited forms of ASAT cyber operations. This trend is expected to intensify in the coming years and may become an increasingly significant security concern in modern societies that rely heavily on space based services.

Space cyber capabilities encompass a broad range of tools and techniques designed to exploit evolving vulnerabilities across multiple layers of space systems. These capabilities include not only traditional cyber operations such as data theft, manipulation, and denial of service, but also activities aimed at disrupting or compromising the control and functionality of satellites, onboard subsystems, individual components, and ground control stations. In recent years, satellite technologies have increasingly adopted advanced architectures such as high performance onboard processing, extensive digitalization of components, and cloud-enabled high performance computing. While these technological developments significantly enhance system performance and operational flexibility, they also expand the potential attack surface for cyber adversaries. Therefore, ensuring the safety and resilience of future space systems will require comprehensive cybersecurity strategies that are integrated across all phases of system design, development, and operation, as well as strengthened international cooperation.

[P-75] A Study on DoD Enterprise DevSecOps Fundamentals

Yee-Jin Cheon[1,2]

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[2]*University of Science and Technology*

Software has long played a critical role in system operation, safety assurance, and mission execution, and its importance is further amplified in systems dominated by information and communications technology (ICT). Modern software-intensive systems must satisfy not only operational and mission requirements but also flexibility and resiliency, while incorporating security considerations throughout the entire software life cycle. Consequently, traditional waterfall-based development is rapidly being replaced by iterative approaches such as Agile and integrated practices such as DevSecOps. Agile methodology improves software value through continuous customer feedback, iterative delivery, and dynamic reprioritization across the project lifecycle. DevSecOps extends this paradigm by embedding security tools and practices into the development pipeline from design through deployment and operations, thereby improving performance, security posture, and operational integrity. This study reviews DevSecOps from the perspective of program and mission execution as presented by the U.S. Department of Defense (DoD), focusing on foundational concepts and principles relevant to defense-oriented ICT systems. In particular, the study discusses how DevSecOps enables continuous integration and delivery while maintaining security as a shared responsibility, and highlights key considerations for adopting DevSecOps in mission-critical environments.

[P-76] A Study on High-Resolution Image Sensor Technologies for Satellite Electro-Optical Payload Systems

Jong-Euk Park, Haeng-Pal Heo
Korea Aerospace Research Institute

Satellite payloads designed for various missions, including high-resolution imaging, employ imaging sensors tailored to their specific objectives. The selection of an appropriate image sensor model considers the overall payload system requirements, such as size, weight, power consumption, development schedule, and mission suitability. Depending on the design and fabrication approach, different types of image sensors—such as CCD, CMOS, and hybrid sensors—may be utilized according to mission needs. Once selected, the image sensor is integrated with the focal plane electronics and aligned with the optical assembly. The alignment and mounting methods are determined based on factors such as ground operational efficiency and structural constraints. Following alignment, the final assembly process includes bonding and bolting procedures. Large volumes of high-resolution image data acquired by the sensors are processed rapidly and transmitted to users without loss or distortion. Data obtained during ground testing can be analyzed using various processing methods. Performance parameters, including modulation transfer function (MTF), signal-to-noise ratio (SNR), and linearity, are evaluated using appropriate measurement techniques depending on the specific test objectives. This paper presents the selection, integration, alignment, data processing, and ground performance evaluation methods of image sensors used in satellite electro-optical payloads. The presented methodology is expected to contribute to the future development of advanced payload systems.

[P-77] Data Classification Methods by Folder for Satellite Data Downlink System

Jong-Tae Lee, Youngsun Kim
Korea Aerospace Research Institute

Earth Observation Satellite takes sensor data of Area of Interest. Sensor data comes from many different types of instruments. Sensor data taken at the same time can be stored in the same folder on the memory storage equipment. Before starting a recording mission, files and a folder are created to save sensor data. At the time of transfer, selectively transfer can be performed on only the required files within the folder. Normally entire files in a folder are transferred by one replay command. It is difficult for the ground station to distinguish between the two consecutive replay mission data without turning off and on of the transmitter when the two data have same VCID and APID. This document describes several ways to data classification by folder and the pros and cons were analyzed. We hope this study provides a foundational framework for designing satellite downlink systems with folder-based mission capabilities.

[P-78] Thermal Deformation Analysis of Large Area Focal Plane Assembly

Jeoung-Heum Yeon, Hyeongu Lim, Young-Sun Kim
Korea Aerospace Research Institute

To achieve a high-resolution image with a wide swath width from a satellite, a large number of pixels along the longitudinal direction is required. Since the number of pixels provided by a single sensor package is limited, a focal plane can be constructed by connecting multiple sensor packages. A large-area focal plane configured in this manner must be structurally and thermally stable. In this study, a thermal deformation analysis is performed on a large-area focal plane constructed by connecting several sensor packages. The deformation of the focal plane is analyzed using the temperature distribution caused by the heat generated during its operation. These analysis results can be utilized for the optical performance budget at the system level.

[P-79] Experimental Evaluation of the Relationship between Microstepping and

Micro-Vibration in a Geared Stepper Motor System

Kilyong Hwang

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This study experimentally investigates the influence of microstepping resolution (full-step, 1/2, 1/4, 1/8, and 1/16) on micro-vibration load characteristics in a pinion-gear coupled stepper motor system. The entire gear system housing was mounted on a Kistler multi-axis force platform. Under constant rotational speed, the microstepping resolution was varied sequentially, and the RMS, peak-to-peak amplitudes, and spectral components of the measured force/moment signals were analyzed.

The results show that 1/2 and 1/4 microstepping significantly reduced transmitted dynamic loads compared to full-step operation, consistent with reduced torque ripple. However, beyond 1/8 microstepping, the reduction effect saturated or even reversed under certain conditions, revealing non-monotonic behavior. This phenomenon is attributed to reduced incremental torque, non-ideal current waveform generation, and interaction between gear mesh stiffness and structural resonance. The findings demonstrate that finer microstepping does not necessarily guarantee lower micro-vibration, and that an optimal microstepping resolution exists for minimizing transmitted dynamic loads in geared stepper motor systems.

[P-80] Analysis of the Optical Module Alignment Result and Focus Sensitivity for the CAP-W Payload of CAS-4 Satellite

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

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[2]*SATREC INITIATIVE*

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.

Precise optical alignment and focus stability are critical factors that determine the imaging quality and operational performance of satellite optical payloads. This result presents a detailed analysis of the optical module alignment results and focus sensitivity for the CAP-W payload onboard the CAS-4 satellite. The CAP-W payload is designed for high-resolution Earth observation, requiring strict control of optical alignment tolerances and focus stability to ensure optimal image quality throughout mission operations.

Alignment verification was conducted through a series of optical performance measurements. The alignment results demonstrated that the optical system met the required mechanical and optical tolerances, ensuring proper optical axis alignment and minimal wavefront error across the imaging field.

In addition to alignment verification, focus sensitivity analysis was performed to evaluate the impact of small positional deviations in the optical components and focal plane assembly on image quality. Sensitivity simulations and experimental measurements were used to quantify how focus shifts caused by mechanical tolerances, thermal variations, and launch-induced disturbances affect the overall optical performance. The analysis indicates that the CAP-W optical system maintains acceptable MTF performance within the defined focus tolerance range, confirming the robustness of the optical design against minor defocus conditions.

The results of this analysis provide valuable insight into the alignment accuracy and focus sensitivity characteristics of the CAP-W payload.

[P-81] A Study on the Development Direction of Landing Detection Sensors for Lunar Landers

Eui-Keun Kim, Seung-Yong Min

Korea Aerospace Research institute

For the successful soft landing of a lunar lander, it is essential to immediately cut off engine thrust either at a specific altitude before touchdown or immediately upon contact. When adopting a scenario that involves shutting down the engine and navigation system right after contact, the landing detection sensor must provide high reliability while maintaining a simple and lightweight structure due to the dry mass constraints of the lander. In particular, robust design optimization is crucial to minimize the risk of malfunctions caused by the extreme temperature environment of the lunar surface and regolith scattering. This study analyzes international development cases and various sensor mechanisms. Based on these findings, it presents design guidelines and technical development directions for landing detection sensors applicable to the Korea Pathfinder Lunar Lander (KPLL).

[P-82] Operational Analysis of Stored Command Utilization in Low Earth Orbit Satellites

Dong-Seok Chae

Korea Aerospace Research Institute

Stored command functionality is widely used in Low Earth Orbit (LEO) satellite missions to enable autonomous spacecraft operations. By preloading command sequences into on-board memory, satellites can execute mission activities without continuous real-time ground intervention. These stored commands

are typically organized using Absolute Time Commands (ATC) and Relative Time Command Sequences (RTCS) within the spacecraft's command scheduling architecture to support time-tagged activities and sequential command execution.
Because the on-board memory allocated for stored commands is inherently limited, efficient utilization of this resource is an important consideration in flight software resource allocation and mission operations planning. During actual satellite operations, the number and complexity of stored commands vary depending on mission phases and operational strategies. Understanding the operational usage patterns of stored command memory is therefore essential for optimizing memory allocation in future spacecraft designs.
This paper analyzes the operational utilization of stored command resources in a LEO satellite mission through an operational trend analysis based on long-term flight data. The study describes the operational concept of ATC and RTCS implemented in the spacecraft flight software and evaluates memory usage characteristics and command scheduling behavior. The results provide practical insights into stored command usage in real mission environments and offer guidance for stored command memory sizing in future satellite developments.

[P-83] Simulation-Based Internal Pressure Integrity Verification of a CubeSat Cold-Gas Propulsion System EQM

Hosub Song[1], Dae-Hee Lee[1,2,3], Jaejin Lee[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Aerospace Engineering KAIST*
[3]*Department of Astronomy and Space Science, University of Science and Technology (UST)*

This study presents the internal pressure integrity verification results of the Engineering Qualification Model (EQM) of a Cold-gas Propulsion System (CPS) developed for CubeSat applications. The design burst pressure was derived by applying a safety factor to the vapor pressure of the R236fa propellant at the maximum survival temperature condition, and aluminum alloy 7075-T6 was selected as the primary casing material. Finite element simulations were conducted for three representative pressure load cases. The results show that, despite peak Von Mises stress concentrations observed at the nozzle casing and main casing ribs, a sufficient burst margin relative to the yield strength was secured, and the maximum structural displacement was confirmed to remain within the allowable range across all cases. These findings demonstrate that the developed CPS casing satisfactorily meets the internal pressure integrity requirements under the burst pressure conditions of the target mission environment.

[P-84] Structural Design of a Large-Area Focal Plane Assembly

Hyeongu Lim, Kilyong Hwang, Jongguk Choe, Jeoungheum Yeon

Korea Aerospace Research Institute

The focal plane assembly (FPA) is a critical component in high-resolution imaging systems, as it maintains detector alignment and directly affects imaging performance. In satellite payload applications, the FPA must ensure structural stability under launch loads and on-orbit operating conditions while minimizing overall mass. This study proposes a structural configuration for a large-area focal plane assembly designed to stably mount and support detectors. The geometry and arrangement of the supporting structure were determined based on system requirements, and key design parameters were defined to satisfy both structural stiffness and strength requirements. To evaluate the structural integrity of the proposed design, finite element analysis (FEA) was performed under load conditions representing the launch environment. The analysis results confirm that the proposed structure satisfies the required structural stability and performance criteria. The proposed structural configuration is expected to be applicable to the design of focal plane assemblies for future high-resolution satellite imaging payloads.

[P-85] Study on the Electrical Power Subsystem Operation Results of LEO Satellite during LEOP

Sung-Woo Park[1], Jeong-Hun Kim[1], Hyoung-Jun Jang[2]

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

Typically, EPS (Electrical Power Subsystem) and several bus equipments such as PCDU (Power Control and Distribution Unit) and OBC (On-Board Computer) of LEO satellites are powered on and keeping stand-by operation conditions before launch. And all the power required for such units is also supplied by bus battery until solar panel separation and sun pointing is achieved after launch vehicle separation. In this paper, results of summary and review on the solar panel deployment operation including power generation characteristics and battery status monitoring such as battery charge/discharge current and voltage trends during the early in-orbit operational check-out phase of LEO satellites are presented. Additionally, detailed review on the in-orbit operation of electrical power components which is in charge of power generation and charging control, conversion and distribution is also included. Finally, verification and analysis results of electrical power subsystem based on in-orbit operational telemetries are summarized.

[P-86] Case Study for the KPLL Rover Deployment Mechanism

Hyun-Jin Shin

Korea Aerospace Research Institute

In the development of a lunar lander for lunar exploration, various payloads will be integrated for science mission. Among these, an autonomous lunar rover designed for unrestricted mobility on the lunar surface, plays a crucial role within the moon landing mission. The rover will be mounted on the lunar lander and deployed and released after landing on the lunar surface. This deployment and release mechanism is a mission-critical single point failure. Therefore, the development of a highly reliable rover deployment mechanism is critical for the success of the lunar lander mission.
This study comparatively analyzes examples of rover deployment mechanisms from existing lunar landers to explore a rover deployment concept suitable for the KPLL (Korean Pathfinder Lunar Lander).

[P-87] Ghost Signal Characterization in Electro-Optical Cameras

Youngchun Youk, Goeun Kim, Minseok Kim, Dongok Ryu

Korea Aerospace Research Institute

Ghost signals in electro-optical cameras can degrade image quality and compromise accurate image performance evaluation. To identify these unwanted signals, we propose a ghost measurement method using a modified modulation transfer function (MTF) test setup. Our method replaces the target used in conventional MTF measurements with a target designed for ghost detection and scans it along the along-track direction while recording the camera response. By tracking signal variations in adjacent pixels and across the camera field of view, the method detects and analyzes unintended signals. Because it enables precise signal acquisition and high-resolution analysis, the method effectively distinguishes ghost components caused by reflections at optical surfaces within the optical system. In this paper, we present the measurement concept, test configuration, and analysis method for ghost signal identification in electro-optical cameras.

[P-88] Analysis of Radiation Test Fluences for Displacement Damage Effect Verification Considering Various Satellite Orbits and Proton Test Source Energies

Young-Jun Cho

Korea Aerospace Research Institute

Optoelectronic parts are vulnerable to space radiation effects especially to Displacement Damage. Displacement Damage is non-ionizing dose effect that degrade core function of optoelectronics in long term by exposure of various space radiation particles. To verify Displacement Damage characteristics of electronic parts, particle radiation testing is required. Most appropriate radiation source for LEO satellite Displacement Damage test is proton. For the Displacement Damage test using proton particles, it is necessary to derive a test level based on the energy of the proton particle source. In this paper, various proton equivalent test fluence levels were derived through analysis according to the satellite orbital radiation environment and proton test source energy.

[P-89] Lightweight Structural Design of a Large-Aperture Spaceborne Primary Mirror for Gravity Effect Reduction

Jongguk Choe

Korea Aerospace Research Institute

In large-aperture space optical systems, the gravity effect on the primary mirror has a significant influence on performance during the system verification phase. The primary mirror must be lightweight for launch and exhibit minimal gravity-induced surface deformation during system verification. However, because the mass increases exponentially with aperture growth, the introduction of a gravity-off loader becomes inevitable. On the other hand, if excessively large deformation must be removed, the gravity compensation system can become overly complex, which may degrade repeatability. Therefore, reducing the gravity effect of the primary mirror itself remains essential. In this study, a case study was conducted to minimize the gravity effect on the primary mirror. The mirror optical axis was arranged perpendicular to the gravity direction, and lightweight patterns of isogrid open-back and semi-open-back configurations were considered. Astigmatism could be effectively mitigated by placing the flexure at the shear center, whereas coma remained as a residual aberration. Coma showed a strong correlation with the first mode of the mirror blank, and the semi-open-back configuration was found to be the most effective.

[P-90] Early In-Orbit Observations and Data Processing of IAMMAP on CAS500-3

Yeonkyung Lee[1], Kwangsun Ryu[1], Jinkuy Kim[1], Wonho Cha[1], Bon-ju Koo[1], Seong-Og Park[1], Younjeong Heo[1], Jongbeom Im[1], Kyungwook Min[2], HyungIl Chun[1], Seunghyeok Choi[1]

[1]*Satellite Technology Research Center, KAIST*
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The Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe (IAMMAP) onboard the Compact Advanced

Satellite CAS500-3 has been successfully operated during its early mission phase, since the successful launch on 27th November in 2025 byKSLV-III (Korean Space Launch Vehicle), providing initial in-orbit measurements of ionospheric plasma and magnetic field variations. This paper presents a newly developed data processing system based on a Network Database architecture, capable of real-time data registration and processing. It reports analysis results from early operational data obtained from the Langmuir Probe (LP), Impedance Probe (IP), and Adaptive In-phase Magnetometer (AIMAG), and defines the Level-0 and Level-1 data product structure and processing framework for IAMMAP observations. Early mission datasets enable observations of electron density and electron temperature associated with the equatorial ionization anomaly (EIA), as well as magnetic field perturbations related to the intensity of the equatorial electrojet (EEJ). These measurements demonstrate the potential for analyzing the complex relationships among major electrodynamic processes occurring in the equatorial ionosphere. In addition, the study discusses the expected data quality and scientific applicability of IAMMAP measurements during the nominal mission phase, based on findings from early operations.

[P-91] Korean Positioning System, KPS, Payload Mechanical Design Integration

Hanjun Lee[1], Joongpyo Kim[1], Dai-Ho Ko[1], Won-Beom Lee[1], Ki-Lyong Hwang[1], Hyun-Ho Kwak[2], Younghoon Choi[2]

[1]*Korea Aerospace Research Institute*
[2]*LIG Nex1*

Korean Positioning System, KPS-1, would be up to IGSO by Space X's Falcon 9 at September 2029. By getting independent positioning technology, the Korean positioning technology would not depend on other countries. As a result, Korea would get centimeter level positioning technology.

KPS payload mechanical designer uses CATIA, an aerospace 3D CAD tool. Using CATIA, and hardware is arranged on payload panel. Preliminary design review was done 2024–2025. This year, August 2026, critical design review is supposed to be done. KPS payload mechanical integration designers are making harness design more detailed. And harness routing is expected to be completed in April this year.

Korea Aerospace Research Institute, KARI is developing Korean Positioning System. And mechanical designers are verifying whether mechanical interface control documents from subcontractor comply with our specification about unit, panel, payload, structure and antenna. And manages shape, mass and material.

분과 소개

우주감시분과

우주감시분과는 우주공간의 환경 보호와 감시, 우주 위험의 예방 및 대비 등 우주상황인식(Space Situational Awareness, SSA) 및 우주위험감시 분야에 대한 학술 활동 및 네트워크 구축을 위하여 설립되었습니다.

분과 연혁

본 분과는 한국천문연구원 박장현 회원을 초대 분과장으로 하여 2018년에 시작되었고, 한국천문연구원 최은정 회원이 2021~2022년 분과장을 맡아 활동하였습니다. 이후 KAIST 안재명 회원이 2023~2025년 분과장을 역임하였으며, 현재 한국항공우주연구원 성재동 회원이 2026~2027년 분과장을 맡고 있습니다.

현재 운영위원회(2026~2027)

현재 한국항공우주연구원 성재동 회원이 분과장을 맡고 있으며, 한국항공우주연구원 이서은 회원이 간사로 활동하고 있습니다. 운영위원으로는 한국천문연구원 최진 회원, 우주항공청 황영은 회원, 스페이스맵 최승환 회원이 활동 중입니다.

주요 활동

우주감시분과에서는 매년 우주과학회 봄/가을 학술회의에서 우주감시 Organized Session과 우주감시분과 워크숍을 개최하며, 해당 분야 연구 정보 공유와 저변 확대를 위해 노력하고 있습니다.

2024년에는 우주과학회 추계 학술회의 기간 중(10월 29일, 사천 KB 인재니움 연수원), **"우주 지속가능성(Space Sustainability) 워크숍"**을 개최하였습니다. 해당 워크숍에서는 산/학/연 전문가들이 모여서 거대군집위성, 능동적 우주물체 제거, 궤도상 서비스 등 새로운 우주시대에 대응하여 필요한 정책적 · 기술적 안전 조치를 논의하는 뜻깊은 시간을 가졌습니다.

2025년에는 우주과학회 추계 학술회의 기간 중(10월 30일, 제주 신화월드), **"민 · 군 우주감시 연구 발전 현황 공유 워크숍"**을 개최하였습니다. 이 워크숍에서는 우주항공청의 우주상황인식 및 우주교통관리 정책 방향, 국가 우주위험감시 사업, 국가 우주감시 재난대응 체계, 그리고 공군의 우주영역인식 발전 방향에 대한 발표와 토론이 이루어졌습니다.



2025 우주감시분과 워크숍(2025.10.30, 제주 신화월드)

회원 참여 안내

우주감시분과에서는 학계, 산업계, 연구기관, 그리고 군에 소속된 70여 명의 회원들이 적극적으로 활동 중입니다. 관심 있는 회원님들의 많은 참여를 기대합니다.

우주관측기기분과

■ 소개

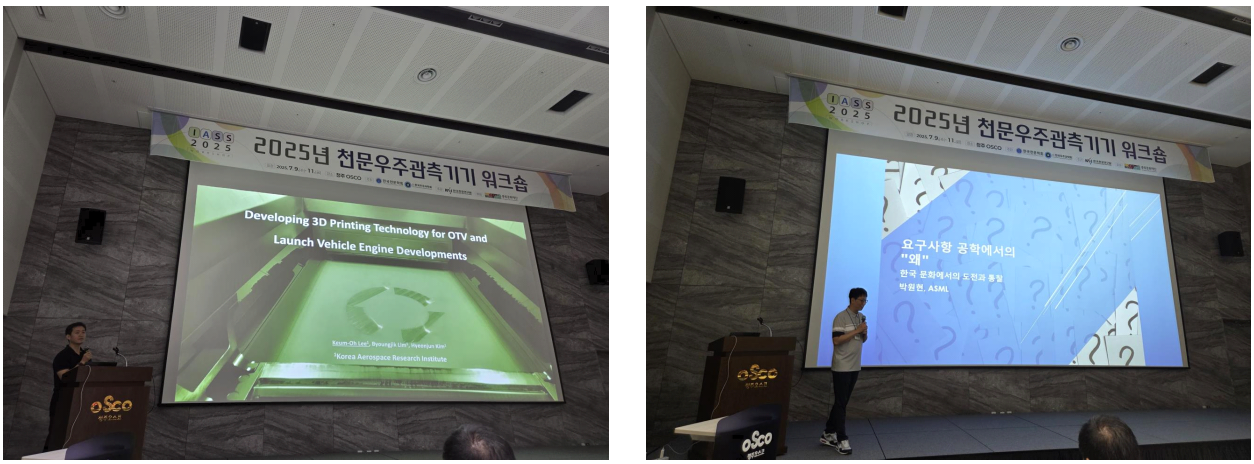
우주관측기기분과는 천문우주관측기기 관련 연구 활동을 증대하기 위해 2018년 5월 봄 학술대회 때 창립총회를 거쳐 탄생하였습니다. 당시 47명의 회원으로 한국천문연구원 문봉곤 책임연구원을 초대 분과장으로 선출하였고, 또한 2기 분과장으로 재임하였습니다. 2022년 10월에 3기 분과장으로 한국천문연구원 한정열 책임연구원이 취임하였고, 2025년 10월 가을 학술대회 때 4기 분과장으로 한국천문연구원 박성준 책임연구원이 새로 선출되었습니다. 우리 분과는 한국천문학회 천문관측기기분과와 공동으로 매년 천문우주관측기기워크숍(IASS)을 개최하고 있습니다. 이를 통해 광학, 광기계, 전자, 제어 소프트웨어, 시스템, 시스템 운영 관리, 데이터 처리 등 다양한 분야의 연구자 간 교류 및 대학 · 대학원 학생의 참여의 기회를 지속적으로 유도하고 있습니다. 아울러 우주관측기기의 국제적인 이슈 및 정책에 대해서 논의하고 이에 대한 학술적인 지원과 정책적 판단의 자료를 공유하고 있습니다.

■ 활동내역

2018년부터 재개한 천문우주관측기기 워크숍이 2025년 16회째 진행되었습니다. 본 분과는 천문학회 천문관측기기분과 주도로 공동으로 2025년 7월 9~11일 청주 오송컨벤션센터(OSCO)에서 '2025년 제16회 천문우주 관측기기 워크숍'을 개최하였습니다. 2025년 천문우주관측기기 워크숍은 3일간 11개의 발표세션에서 총 141명의 참석자가 모여 총 45편 발표(초청강연 4편, 구두발표 38편, 포스터발표 3편)가 있었습니다. 특히, 우주항공청에서 "대한민국 우주과학탐사 추진전략" 정책방향을 소개하고, 산업계 위주의 패널토론이 진행되었습니다. LIG넥스원, 그린광학, ㈜래디언트솔루션, 레오스페이스㈜, 스페이스빔, 한화시스템, 에이디솔루션, SpaceSCANeR, 에스엠테크 등 패밀리 기업이 참가하였습니다. 여름학교는 시스템 엔지니어링을 주제로 1일 동안 진행되었으며 많은 천문우주학 및 관측기기 관련 대학교 학부생들이 참가했습니다.

■ 계획

2026년에는 본 분과가 주도하는 천문우주관측기기 워크숍에 천문학회 천문관측기기분과와 공동 주관을 맡아 진행합니다. 2026년 7월 13~16일에는 여수 히든베이호텔에서 개최할 예정입니다.



〈워크숍 발표 현장 사진〉



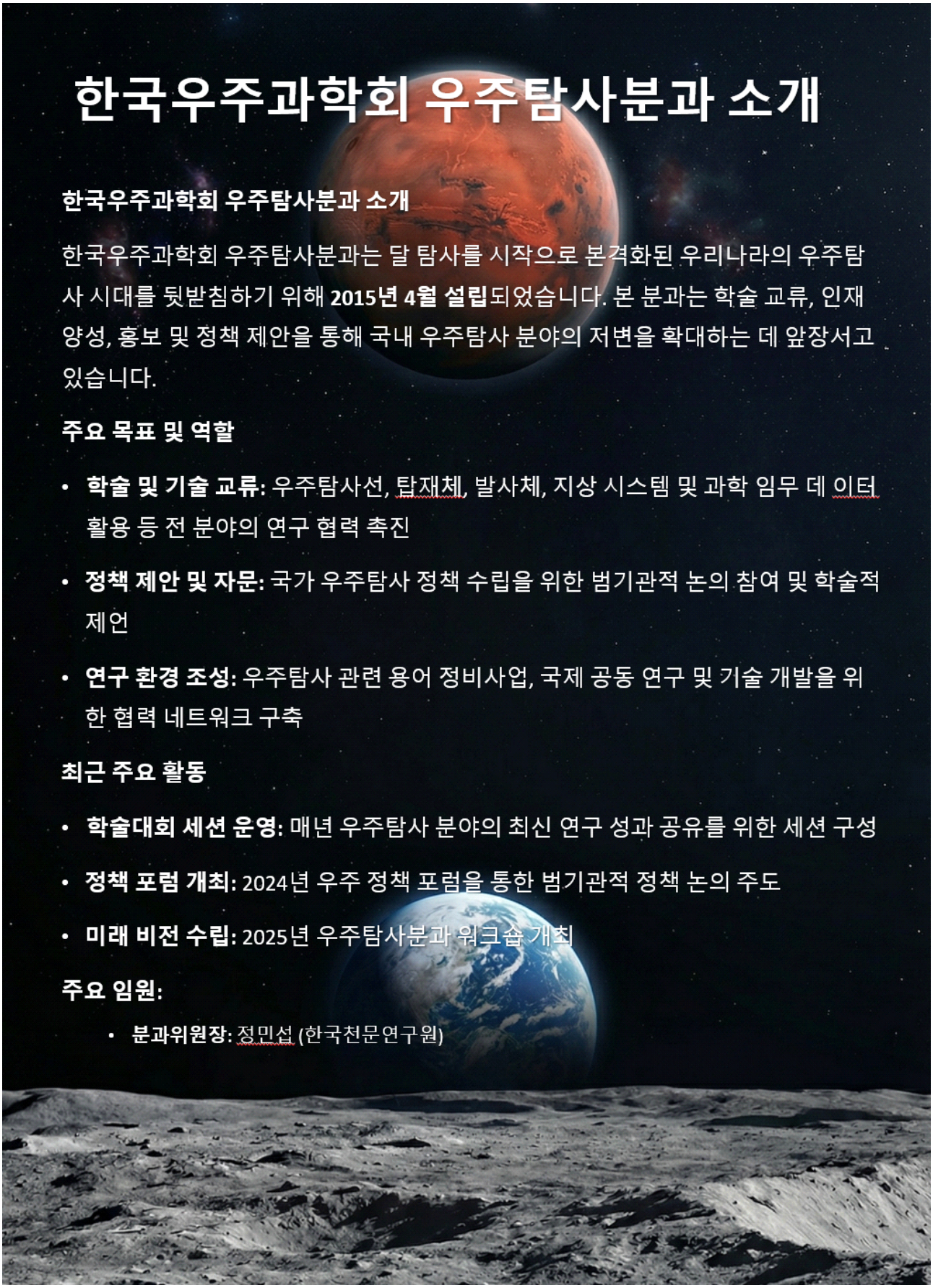


〈패널토론〉





〈여름학교 강의 현장(좌) 및 단체사진(우)〉


한국우주과학회 우주탐사분과 소개
한국우주과학회 우주탐사분과 소개
한국우주과학회 우주탐사분과는 달 탐사를 시작으로 본격화된 우리나라의 우주탐사 시대를 뒷받침하기 위해 2015년 4월 설립되었습니다. 본 분과는 학술 교류, 인재 양성, 홍보 및 정책 제안을 통해 국내 우주탐사 분야의 저변을 확대하는 데 앞장서고 있습니다.
주요 목표 및 역할
• 학술 및 기술 교류: 우주탐사선, 탑재체, 발사체, 지상 시스템 및 과학 임무 데 이터 활용 등 전 분야의 연구 협력 촉진
• 정책 제안 및 자문: 국가 우주탐사 정책 수립을 위한 범기관적 논의 참여 및 학술적 제언
• 연구 환경 조성: 우주탐사 관련 용어 정비사업, 국제 공동 연구 및 기술 개발을 위한 협력 네트워크 구축
최근 주요 활동
• 학술대회 세션 운영: 매년 우주탐사 분야의 최신 연구 성과 공유를 위한 세션 구성
• 정책 포럼 개최: 2024년 우주 정책 포럼을 통한 범기관적 정책 논의 주도
• 미래 비전 수립: 2025년 우주탐사분과 워크숍 개최
주요 임원:
• 분과위원장: 정민섭 (한국천문연구원)

초소형위성분과

지난 2020년 4월 발족한 초소형위성분과는 초기 발기인 40명으로 시작하여, 2026년 3월 현재 회원 수가 91명으로 증가하였습니다. 2025년에는 제10회 초소형위성 워크숍을 성공적으로 주관하였으며, 산·학·연·관·군 관계자 약 430여 명이 참석하는 등 우리 학회 최대 규모의 워크숍으로 자리매김하였습니다. 이 행사는 국내 뉴스페이스 분야를 선도하는 민·군 연구자들이 한자리에 모이는 대표적인 소통의 장으로 성장하고 있습니다. 특히 10주년 기념행사로 재즈 가수 웅산을 초청하여 참가자들과 뜻깊은 시간을 함께하기도 하였습니다.

올해 제11회 초소형위성 워크숍은 5월 27일(수)부터 29일(금)까지 부산 해운대 웨스틴조선호텔에서 개최될 예정입니다. 첫째 날은 산업체의 날(Industrial Day)로 운영되어, 참여기업과 참석자 간 네트워킹, 투자사와의 미팅, 그리고 스타트업들의 3분 IR 피치(홍보 스피치) 등이 진행될 예정입니다. 둘째 날에는 개회식에 이어, 산·학·연·관·군이 함께하는 「초소형위성 발전 방안」 패널 토의와, New Space 분야를 이끌어가는 주요 인사를 초청한 키노트 강연이 마련되어 있습니다. 이를 통해 초소형위성의 미래 활용에 대한 공감대를 더욱 확대할 수 있을 것으로 기대됩니다. 셋째 날에는 최근 활발히 연구되고 있는 초소형위성 관련 기술에 대한 학술 발표가 진행될 예정입니다.

이번 워크숍에서는 AI 기반 동시통역 서비스를 제공함으로써, 한국어에 익숙하지 않은 해외 참가자들도 적극적으로 참여할 수 있는 국제적인 행사로 한층 더 발전시킬 계획입니다.





태양우주환경분과(https://sse.kasi.re.kr)

1. 설립 및 목적

태양우주환경분과는 태양-행성 간 공간, 자기권, 전리권 및 고층대기 영역의 학술 교류와 협력 증진을 목적으로 2015년에 설립되었습니다. 본 분과는 정기 학술모임 개최 및 관련 기관 간의 긴밀한 협력을 통해 국가적 · 국제적 차원의 태양우주환경 분야 발전을 위해 활동하고 있습니다.

2. 회원 및 조직 구성

한국우주과학회 소속 연구자로 구성되어 있으며, 현재 총 154명의 회원이 활동을 이어가고 있습니다.

- 역대 위원장: 초대 곽영실(천문연구원) 위원장을 비롯하여, 유광선(과학기술원), 오수연(전남대학교), 지건화(극지연구소), 이진이(경희대학교) 위원장이 역임하며 분과의 도약과 발전을 이끌었습니다.
- 현 운영진(2026년~2027년): 박경선(충북대학교) 위원장과 이종길(충북대학교) 총무를 비롯하여 권혁진(극지연구소), 나고운(경희대학교), 박성홍(천문연구원), 박재흥(천문연구원), 이시백(경희대학교), 이우경(천문연구원) 회원이 운영위원으로 활동하며 분과를 위해 봉사하고 있습니다.

3. 주요 활동 및 성과

• 학술 워크숍 및 학문 후속세대 양성

2013년 전리권/고층대기연구 워크숍, 2014년부터 근지구우주환경연구 워크숍으로 정례화되어 태양우주환경 전 분야의 학술 교류를 선도해 왔습니다. 2025년 1월에는 한국우주과학회, 한국천문학회, 그리고 한국천문연구원이 공동 주관하고 SELab 후원한 '태양우주환경 겨울학교 및 워크숍'을 개최하였습니다. 이 행사에서는, 전국 10개 기관 소속 36명의 학생이 15명의 박사급 전문가 멘토와 함께 '태양폭풍과 지자기폭풍' 주제로 실습 분석과 학술 발표를 진행하여 차세대 연구자 양성에 기틀을 마련하였습니다.

• 학술용어 정비 및 표준화 기반 마련

2024년 한국우주과학회와 충북대학교 국어문화원 협력으로 태양우주환경 핵심 용어 200여 개를 정비하여 표준 정의를 마련했고, 정비된 용어 체계가 학술 소통의 전문적인 연구 환경을 견인하고 있습니다.

• 태양권 우주환경 미션 과학 임무 지원

도요샛(SNIPE), 차세대중형위성 3호 로키츠(ROKITS), 국제우주정거장용 태양코로나그래프(CODEX) 등 태양권 우주환경 미션의 성공과 우주과학 탐사선, L4 태양권 우주관측소 구축 등 미래 미션 발굴을 위해 과학적 토대를 제공하며 기술적 실현을 뒷받침하고 있습니다. 과학 임무의 기획에서 실제 탑재체 개발 참여까지, 각 미션의 과학적 가치와 기술적 완성도를 높이는 데 이바지해 왔습니다.



〈분과 워크숍 발자취〉

우주교육유산분과

2025년 10월 이사회의 승인 이후, 2026년부터 우주교육유산분과가 정식으로 활동을 시작하였습니다. 우주교육유산분과는 우주과학 분야에 관련된 과학 교육 콘텐츠 강화와 과학 문화의 보급 및 소중한 과학유산의 가치 재발견을 목적으로 결성되었습니다. 급변하는 우주 시대에 발맞춰, 과거의 기록을 보존하고 미래 세대에게 그 가치를 전달하는 가교 역할을 수행하고자 합니다.

우리 분과는 먼저 우주 유산 및 과학교육 관련 정기 워크숍과 컨퍼런스를 개최하여 학술 교류를 활성화하고, 회원 간 소통과 화합의 장을 마련하고 있습니다. 출연(연) 및 대학이 보유한 역사적 우주관측기기와 자료를 발굴하여 과학 유산으로서의 가치를 조명하고 이를 체계적으로 보존할 수 있도록 지원하며, 발굴된 유산들이 국공립 과학관과 천문대에서 전시 및 연구될 수 있도록 하는 학술적 활동을 지향하고 있습니다.

1. 주요 활동

- 봄 · 가을 학술대회에서 '우주교육유산' 발표세션을 정례화
- 2026 고천문우주 컨퍼런스 & 천문우주 교원워크숍(7.31~8.31, 국립과천과학관)의 성공적인 개최
- 우주분야 교과서(대학교재)의 학회 추천 도서로 지정을 위한 제도 기획

2. 회원 구성

- 회원수: 39명

3. 문의

- 위원장: 민병희 (한국천문연구원, bhmin@kasi.re.kr)
- 부위원장: 송인옥(한국과학영재학교, song.inok@ksa.kaist.ac.kr)
  조영인(한국천문연구원, young@kasi.re.kr)

2025 KSSS Honors

학술상



김관혁(경희학교)

한국과학기술단체총연합회 과학기술우수논문상



강현지(나라스페이스)

두진우주과학자상



권혁진(극지연구소)

신진 우주과학자상



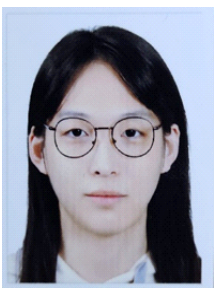
정종일(한국천문연구원)

에스이랩상



최두영(충북대학교)

에스이랩상



이진우(조선대학교)

에스이랩상



백준호(경희대학교)

에스이랩상



김우진(UST천문연)

한국우주과학회보
제35권 1호 2026년 4월
전화 042-865-3391 (FAX: 042-865-3392)
학회 홈페이지 http://ksss.or.kr

발행인 진 호
편집인 김주현 · 고미희
발 행 사단법인 한국우주과학회
인 쇄 ㈜거목문화사/거목인포(02-2277-3324)

학회 소재지 대전시 유성구 대덕대로 776 한국천문연구원 내
전화: 042-865-3391 / 팩스: 042-865-3392
학회대표메일: ksss@ksss.or.kr

도움을 주신 기업 및 연구홍보 사업단

기관명	대표	주소
(주)세트렉아이	김이을	대전광역시 유성구 유성대로 1628번길 21, 1층
㈜나라스페이스테크놀로지	박재필	서울특별시 영등포구 국회대로 632, 14-15층
㈜에스이랩	오승준	서울시 강남구 논현동 66-3 진영빌딩 5층
㈜에스엘랩	김일훈	경기도 용인시 처인구 백옥대로 2186번길 68
(주)에이디솔루션	최형석	대전 유성구 대학로 31, 1101호

도움을 주신 연구홍보 사업단

사업명	연구책임자
한국천문연구원 ‖ 국가 우주상황인식시스템(K-SSA) 개발 사업	최은정
한국천문연구원 ‖ 달 탐사선 탑재체	심채경
한국천문연구원 ‖ 긴급대응 광역 감시정찰 큐브편대위성 개발	이재진
한국천문연구원 ‖ 차세대 우주환경 연구	곽영실
극지연구소 ‖ 남극장보고과학기지 상공 극지고층대기 극관-오로라대 경계 특성 규명	지건화

미래도전국방기술 연구개발사업

Space SCANeR Satellite Constellation Architecture for New Concept Surveillance and Reconnaissance

긴급대응 광역 감시정찰 큐브편대위성 개발



4기 위성 편대 비행을 통해
빠른 재방문 주기로
연속 동일 지역 촬영

Continuous EO/IR imaging of target area with short revisit cycles via a 4-satellite cross-trackformation flight

4기 위성 편대 비행으로
국내최대 EO/IR 광역 영상 획득

Largest wide-area EO/IR imaging of target area in South Korea via a 4-satellite along-track formation flight

방위사업청 | 국방과학연구소 Agency for Defense Development | 한국천문연구원 | KAIST | 경희대학교 KYUNG HEE UNIVERSITY | 국립한밭대학교

PASL
Polar Aeronomy & Space Science Lab.
Korea Polar Research Institute

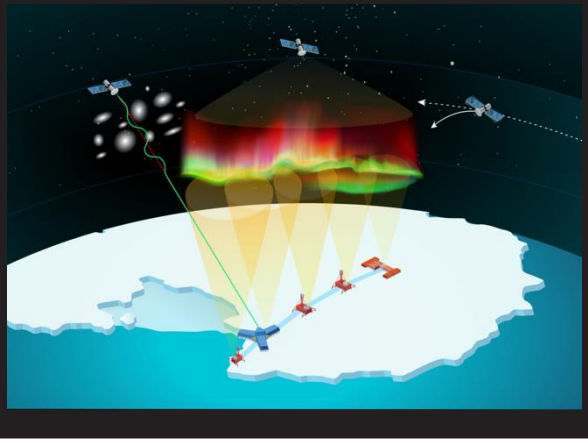
극지에서 열리는 우주로의 창
KOPRI 우주과학

Polar Aeronomy & Space Science Lab (PASL)

오로라를 보면 우주를 알 수 있다?



남극 우주환경 관측망



주요 연구 분야

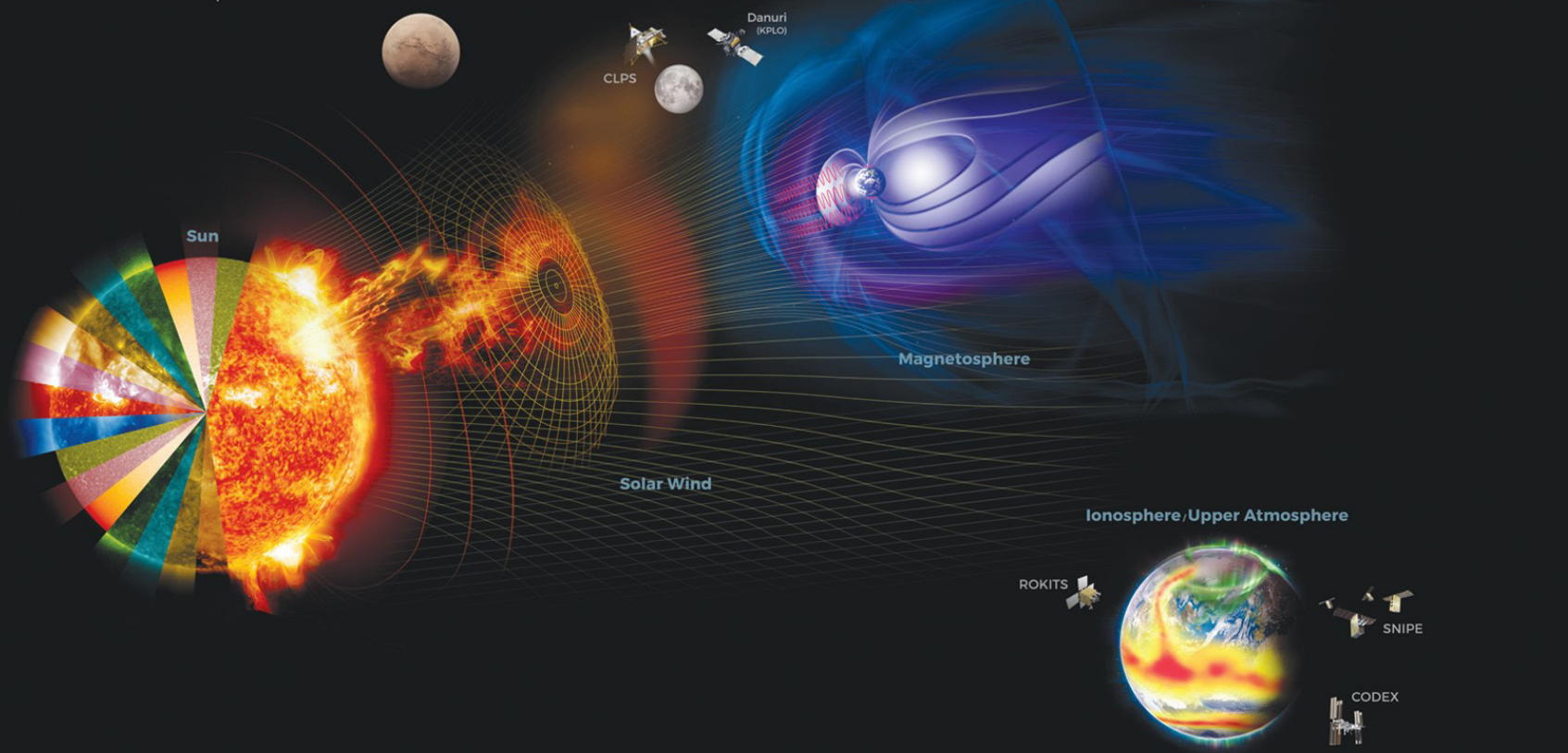
극지고층대기 오로라 관측 연구
극지 열권/전리권 상시 모니터링
대기중력파 / 지구 자기장 변화 감시
자기권-전리권 상호작용 연구

월동연구대 / 연수생 관련 문의
지건화 ghjee@kopri.re.kr

What is the Next Generation Space Weather?

+ Comprehensive understanding of the energy linkage process of the Sun-Earth space environment
+ Expansion of space weather research into the heliosphere

한국천문연구원
Korea Astronomy & Space Science Institute



KDC for SDO KSWRC SWPy

세트렉아이

SATREC INITIATIVE

국내 유일의 위성체계 개발·수출기업

SpaceEye-T

Bands	PAN + 4 MS
GSD	PAN 0.25m, MS 1m
Swath Width	12km
D/L Speed	2.0 Gbps

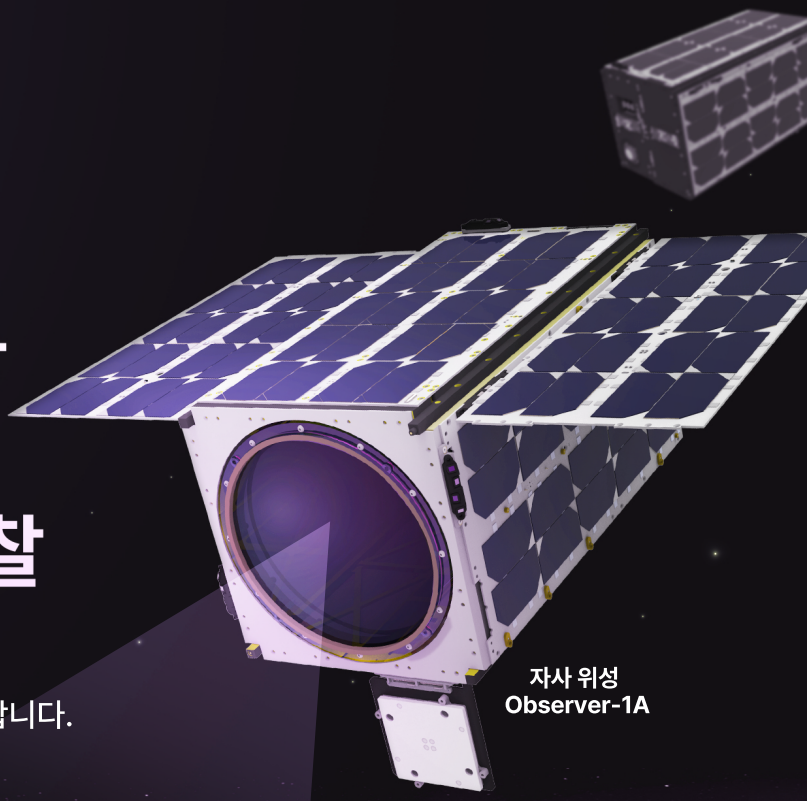




NARA SPACE

초소형 위성이 제공하는 새로운 시각, 더 넓은 세상에 대한 통찰

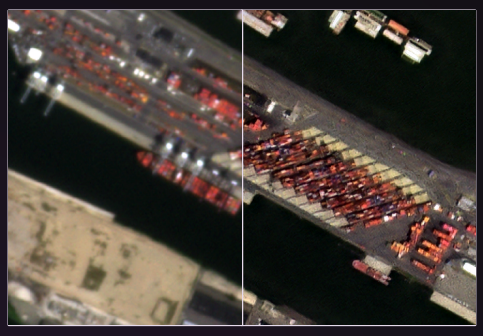
위성 제조, 운용부터 영상을 통한 산업별 분석까지.
혁신적인 기술로 우주를 일상의 가장 가까운 곳으로 연결합니다.



나라스페이스 위성영상 분석 솔루션

MULTI-SENSOR DATA FUSION ▶ MULTISPECTRAL + HYPERSPECTRAL + SAR

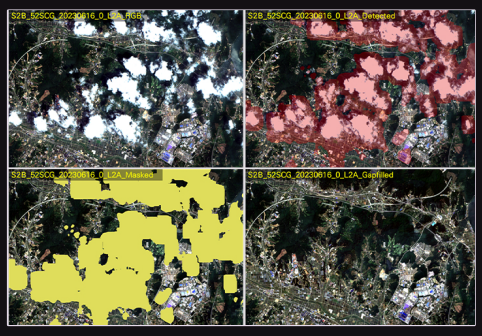
나라스페이스는 글로벌 데이터 파트너와 협력하여 다중 센서 데이터 융합 기술을 적용함으로써 정밀하고 신뢰도 높은 분석 결과를 제공합니다.



초해상화
최대 3배 선명도 제공



객체 탐지
정확도 30% 향상



결측 보완
딥러닝 기반 고정밀 결측 영역 복원

EXPAND OUR UNIVERSE

링크트리
QR 코드