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2023년 4월 제32권 1호

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사단법인 한국우주과학회
The Korean Space Science Society

차 례

<사단법인 한국우주과학회 입회 안내>

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

▣ 보낼곳: 한국우주과학회
34055 대전광역시 유성구 대덕대로 776
한국천문연구원 내
전화 042-865-3391
팩스 042-865-3392

▣ 은행계좌:
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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 학회운영에 대한 규정 제2조에 의거한 사항입니다.

※ 뒷면의 입회원서를 복사하여 사용해 주십시오.

[표지사진 설명]

'우주위험 대응체계 구축사업'은 인공우주물체의 탐지 · 식별 · 추적감시를 위한 독자 인프라 및 우주위험대응 통합시스템 등을 구축하여 국가 우주위험 대응능력 강화하기 위해 국가지정 '우주환경감시기관'인 한국천문연구원이 260억 원의 예산으로 2023년부터 5년간 수행할 예정이다.

입 회 원 서

<table>
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영문</td><td>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</td><td colspan="7">- 중복선택 가능
☐ 태양우주환경분과 ☐ 우주탐사분과 ☐ 우주관측기기분과
☐ 우주감시분과 ☐ 초소형위성분과 ☐ 활동 안함</td></tr>
<tr><td>경 력</td><td colspan="7"></td></tr>
<tr><td>연구 업적</td><td colspan="7"></td></tr>
</table>

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

년 월 일

신청인: (인)

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

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

사단법인 한국우주과학회 귀중

한국우주과학회
2023년 봄 학술대회

일　　시 : 2023. 4. 26.(수) ~ 28.(금)

장　　소 : 창원 컨벤션센터

발표논문 : 초청강연 4편, 구두발표 96편, 포스터발표 76편, 총 176편

포스터 집중 발표 : 2023. 4. 27.(목)　15:50~18:00

후　　원 :

GNTO 경남관광재단 GYEONGNAM TOURISM ORGANIZATION

ktl 한국산업기술시험원 Korea Testing Laboratory

대한민국육군 Republic of Korea Army

사단법인 한국우주과학회

등록 및 안내

1. 등록

회원의 등록비는 250,000원이며, 학생회원과 정회원 중 석·박사과정(전일제) 학생은 150,000원입니다. 사전등록을 하신 회원은 학회보, 명찰을 수령하시기 바랍니다. 등록비 영수증은 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: 포스터발표는 4월 26일(수) 15시까지 지정된 장소에 게시하고, 28일(금) 10시까지 수거해 주시고, 집중발표 시간 27일(목) 15:50~18:00에는 자신의 포스터 앞에서 회원들의 질문에 답할 수 있도록 준비해 주시기 바랍니다. 위촉된 심사위원이 우수 포스터발표를 선정하여 폐회식 때 시상을 합니다. 발표시간에 자리에 없으면 수상자에서 제외됨을 유의해 주시기 바랍니다. 포스터를 부착하지 않거나 학회 종료 후 수거하지 않은 회원은 추후 학회발표가 제한될 수 있습니다.

3. 발표장

Convention I	Convention II	Convention III	301호	302호	Lobby
- 특별강연 - Invited Talk (I), (II), (III) - 태양 및 우주환경 (I), (II), (III), (IV), (V)	- SS: Open New Horizon with L4 Mission (I), (II) - 우주감시 & 워크숍 - 과학탐사를 위한 대기권 재진입 (ARES)	- Space Exposition - 미래세대를 위한 아름다운 동행, 우주과학이 우주산업을 만났을 때	- 안보우주 (I) - 우주기술/지상 및 우주 인프라 운영 기술 - SS: Space Laser Communication - 달과 우주탐사: 과학기술 그리고 정책/초소형위성 - SS: 관측위성 탑재체 기술 확보방안	- 안보우주 (II)	포스터 발표

4. 교통 안내

가. 주소: 경상남도 창원시 성산구 원이대로 362 (대원동) (Tel: 055-212-1000)

나. 교통편: KTX - 창원중앙역 ↔ 센터: 약 5km (차량 10분 소요), 운행 시내 버스: 220, 221
고속/시외버스 - 창원종합버스터미널 ↔ 센터: 약 2km (차량 5분 소요), 운행 시내 버스: 103, 506

5. 구두발표 색인표

I - 1 - 1
세션번호 발표장 발표순서

6. 안내

▶ 행사장 내 일회용품 사용 지양으로 페트병 물병 및 종이컵을 제공하지 않습니다.
회원들의 개인 텀블러나 컵을 이용하시길 부탁드립니다.

▶ 경남관광재단의 지원금 정산을 위해 개인정보보호법에 따라 개인정보를 제공한다는 사실을 알려드립니다.
(국적, 성명, 소속, 이메일)

2023 KSSS SPRING CONFERENCE PROGRAM

Apr. 26. (Wed)

Time	Functions					
12:00~	Registration : Convention 3F					
13:30~13:40	Opening Ceremony : Convention I 개회사 : 이 유 회장 축사 : 주성운 소장 (육군본부 정책실장)					
13:40~13:50	Break Time					
13:50~14:20	Invited Talk I Room : Convention I Chair : 민경욱 (과기원) 황경주 (Southwest Research Institute) Cross-Scale Processes of Magnetic Reconnection Observed by MMS					
14:20~14:30	Break Time					
Room	**Convention I**		**Convention II**		**301호**	
Session I	**태양 및 우주환경 I** Chair : 권윤영 (천문연)		**SS: Open New Horizon with L4 Mission I** Chair : 황정아 (천문연)		**안보우주 I** Chair : 최호성 (육군)	
14:30~14:45	I-1-1	최광선	I-2-1	이대영	I-3-1	송세찬
14:45~15:00	I-1-2	이우경			I-3-2	한상설
15:00~15:15	I-1-3	권윤영	I-2-2	최두영	I-3-3	조용완
15:15~15:30	I-1-4	이재욱	I-2-3	유지현	I-3-4	최성환
15:30~15:45	I-1-5	최정림	I-2-4	서정준	I-3-5	신동윤
15:45~16:00	I-1-6	박이경	I-2-5	김록순	I-3-6	최현주
16:00~16:15			I-2-6	정현진		
16:15~16:25	Break Time					
Session II	**태양 및 우주환경 II** Chair : 김수진 (천문연)		**SS: Open New Horizon with L4 Mission II** Chair : 선종호 (경희대)		**우주기술/지상 및 인프라 운영기술** Chair : 임조령 (항우연)	
16:25~16:40	II-1-1	김연한	II-2-1	이경선	II-3-1	임유진
16:40~16:55	II-1-2	김수진	II-2-2	박성홍	II-3-2	최진행
16:55~17:10	II-1-3	송병권	II-2-3	김홍배	II-3-3	차상목
17:10~17:25	II-1-4	나현옥	II-2-4	박재익	II-3-4	이진아
17:25~17:40	II-1-5	한윤기	II-2-5	이진성	II-3-5	이정현
17:40~17:55	II-1-6	정세헌	II-2-6	황정아		

Apr. 27. (Thu)

Time	Functions							
09:00~09:30	**특별강연** Room : Convention I Chair : 이호규 (과학기술정책연구원) 임종빈 (과학기술정책연구원 국가우주정책연구센터) 제4차 우주개발진흥 기본계획 및 우주탐사 로드맵 수립 계획 소개							
09:30~09:40	Break Time							
Room	**Convention I**		**Convention II**		**301호**		**302호**	
Session III	**태양 및 우주환경 III** Chair : 김정헌 (천문연)		**우주감시** Chair : 최 진 (천문연)		**SS: Space Laser Communication** Chair : 임형철 (천문연)		**안보 우주 II** Chair : 송세찬 (육군)	
09:40~09:55	III-1-1	지건화	III-2-1	이희재	III-3-1	정진평	III-4-1	정영진
09:55~10:10	III-1-2	이겨레	III-2-2	김윤학	III-3-2	이지훈	III-4-2	이병선
10:10~10:25	III-1-3	김관혁	III-2-3	박장현	III-3-3	강원석	III-4-3	정유연
10:25~10:40	III-1-4	곽재영	III-2-4	최승환	III-3-4	백기옥	III-4-4	김건희
10:40~10:55	III-1-5	양희수	토론		III-3-5	여찬일		
10:55~11:10	III-1-6	강주형	III-2-5	유중현	III-3-6	한석기	III-4-5	정종균
11:10~11:25	III-1-7	감호식	III-2-6	신종기	III-3-7	주석영	III-4-6	김규민
11:25~11:40	III-1-8	김정헌	III-2-7	유지웅	III-3-8	김건희	III-4-7	최호성
11:40~11:55	III-1-9	채종철	III-2-8	최은정	III-3-9	임형철		
11:55~13:00	Lunch							
Session IV	**태양 및 우주환경 IV** Chair : 이창섭 (극지연)		**우주감시 워크숍**		**달과 우주탐사: 과학과 기술 그리고 정책/ 초소형위성** Chair : 서행자 (한컴인스페이스)			
13:00~13:15	IV-1-1	남욱원	안재명(과기원) 조중현(천문연) 성재동(항우연) 이동헌(한국항공대)		IV-3-1	이재희		
13:15~13:30	IV-1-2	이창섭			IV-3-2	박현후		
13:30~13:45	IV-1-3	이강우			IV-3-3	성세현		
13:45~14:00	IV-1-4	김우진			IV-3-4	정민섭		
14:00~14:15	IV-1-5	이재원						
14:15~14:30	Break Time							
14:30~15:00	**Invited Talk II** Room : Convention I Chair : 최기혁 (항우연) 김성훈 (한국항공우주연구원 부원장) The Era of Space Economy and the Role of Korea Aerospace Research Institute							
15:00~15:10	Break Time							
15:10~15:40	**Invited Talk III** Room : Convention I Chair : 이우경 (천문연) 박찬흠 (한림대학교) BioCabinet (Bio 3D Printing and 3 Dimensional Culture System) for Space Biomedicine							
15:40~15:50	Photo Time							
15:50~18:00	**Poster Session**							
18:00~20:30	**Banquet (그랜드 머큐어 앰버서더 호텔 내 가든하우스)**							

Apr. 28. (Fri)

Time	Functions					
Room	Convention I		Convention II		301호	
Session V	태양 및 우주환경 V Chair: 이원석(연세대)		달과 우주탐사: 과학탐사를 위한 대기권 재진입 (ARES) Chair : 이덕행, 문홍규 (천문연)		SS: 관측위성 탑재체 기술 확보방안 Chair : 천이진 (항우연)	
09:00~09:15	V-1-1	이원석	V-2-1	안효근	V-3-1	강금실
09:15~09:30	V-1-2	함영배	V-2-2	최기혁	V-3-2	정재훈
09:30~09:45	V-1-3	강수상	V-2-3	이창훈	V-3-3	안재현
09:45~10:00	V-1-4	이영숙	V-2-4	전은지	V-3-4	박성준
10:00~10:15	V-1-5	Sascha Trippe	토론			
10:15~10:30			V-2-5	김현준		
10:30~10:45			V-2-6	나재정		
10:45~11:00			V-2-7	김재강		
11:00~11:15			V-2-8	김성원		
11:15~11:20	세션 마무리					
11:20~12:00	**폐회사 (Closing Ceremony) / 시상식**					

Poster Session

4. 27. (Thu) 15:50~18:00

Area	No	Author	Area	No	Author
우주기술	P-1	강수연 (항우연)	우주응용	P-39	김영선 (항우연)
	P-2	강치호 (항우연)		P-40	명환춘 (항우연)
	P-3	김명길 (항우연)		P-41	박종억 (항우연)
	P-4	김민준 (항우연)		P-42	이종태 (항우연)
	P-5	김송란 (항우연)		P-43	이주희 (항우연)
	P-6	김영윤 (항우연)		P-44	정대준 (항우연)
	P-7	김용복 (항우연)	태양 및 우주환경	P-45	Hoang Nguyen (천문연)
	P-8	김진혁 (항우연)		P-46	Sumiaya Rahman (경희대)
	P-9	김희경 (항우연)		P-47	나성호 (충남대)
	P-10	박균상 (항우연)		P-48	박경선 (충북대)
	P-11	박근주 (항우연)		P-49	박진혜 (경희대)
	P-12	박봉규 (항우연)		P-50	손지현 (경희대)
	P-13	박성우 (항우연)		P-51	이영숙 (충남대)
	P-14	박응식 (항우연)		P-52	이진이 (경희대)
	P-15	박종석 (항우연)		P-53	이환희 (천문연)
	P-16	박종오 (항우연)		P-54	전홍달 (경희대)
	P-17	송준영 (항우연)	달과 우주탐사: 과학과 기술 그리고 정책	P-55	김연규 (항우연)
	P-18	신현규 (항우연)		P-56	김주현 (항우연)
	P-19	양승은 (항우연)		P-57	심채경 (천문연)
	P-20	양지모 (항우연)		P-58	이준현 (경희대)
	P-21	연정흠 (항우연)		P-59	임조령 (항우연)
	P-22	윤석택 (항우연)		P-60	조우인 (경희대)
	P-23	윤영수 (항우연)		P-61	조은진 (천문연)
	P-24	이상록 (항우연)		P-62	홍익선 (충남대)
	P-25	이서림 (항우연)	ARES	P-63	김대영 (항우연)
	P-26	이승욱 (충북대)	안보우주	P-64	정옥철 (항우연)
	P-27	이준원 (항우연)	우주감시	P-65	성재동 (항우연)
	P-28	임은숙 (항우연)		P-66	송석민 (충남대)
	P-29	임현수 (항우연)		P-67	정유연 (항우연)
	P-30	장윤정 (항우연)	지상 및 우주 인프라 운영기술	P-68	김준호 (기상청)
	P-31	조창권 (항우연)		P-69	이용석 (천문연)
	P-32	채동석 (항우연)	기타	P-70	강철 (항우연)
	P-33	최두영 (충북대)		P-71	김효준 (항우연)
	P-34	최정수 (항우연)		P-72	박성홍 (천문연)
	P-35	허성식 (항우연)		P-73	서장원 (항우연)
	P-36	황기룡 (항우연)		P-74	신근웅 (항우연)
	P-37	김구혁 (항우현)		P-75	윤지연 (항우연)
우주천문	P-38	강현지 (경희대)		P-76	성기평 (천문연)

제6회 우주감시분과 워크숍

- **제목:** 우주 위험 감시 연구 개발 현황 공유 및 협력 워크숍
- **일시:** 2023년 4월 27일(목) 13:10~14:30
- **장소:** 창원 컨벤션센터, Room TBD
- **모시는 글**

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

이번 워크숍에서는 국내 주요 기관에서 이루어지고 있는 우주 감시 연구 현황을 공유하고, 협력 방안을 논의하고자 합니다. 또한 새로 구성된 우주과학회 우주감시분과 운영위원회를 소개하고, 분과의 활성화를 위한 토론의 시간을 가질 것입니다. 관심있는 분들의 많은 참석을 기대합니다. 감사합니다.

- **프로그램**

시간	주제	발표
	우주 위험 감시 연구 현황 공유 및 협력 워크숍	
13:10~13:15	우주감시분과 워크숍 개회	안재명 (KAIST)
13:15~14:15	"우주위험 대응체계 구축" 과제 소개	조중현 (한국천문연구원)
	한국항공우주연구원의 우주위험 감시 연구 소개	성재동 (한국항공우주연구원)
	2023~2024 우주감시분과 운영 안내	안재명 (KAIST)
14:15~14:30	우주감시분과 활성화를 위한 토의	이동헌 (한국항공대학교)

* 우주감시분과 위원장 안재명 (KAIST), 간사 이동헌 (한국항공대학교)
운영위원: 강병국 ((주)솔탑), 김명진 (한국천문연구원), 김은희 (세종대학교), 성재동 (한국항공우주연구원), 최진 (한국천문연구원)

워크숍 주제 발표 초록

[발표 1] 우주위험 대응체계 구축사업 – 우주위험대응 통합시스템 개발

조중현 (한국천문연구원)

2023년부터 시작된 '우주위험 대응체계 구축사업'은 '우주위험대응 통합시스템 개발'과 '중고궤도위성 광학감시시스템 구축', 2개의 내역사업으로 구성되어 있다. 먼저 개발을 시작한 우주위험대응 통합시스템은 우주위험으로부터 국민과 우주자산을 보호하기 위한 국가 우주위험대응 통합시스템을 개발하고 구축하는 것을 목표로 하고 있다. 이 통합시스템은 우주위험 데이터 통합관리시스템, 통합분석시스템, 그리고 예경보 시스템으로 구성된다. 2027년 말까지 개발 및 구축을 완료하고 운영을 시작할 예정이다.

[발표 2] 한국항공우주연구원의 우주위험 감시 연구 소개

성재동 (한국항공우주연구원 SSA연구실)

현재 한국항공우주연구원에서는 저궤도위성 5기, 정지궤도위성 3기, 달탐사선 1기의 우주자산을 운영하고 있으며, 다수의 후속 위성들의 설계, 개발, 발사, 운영을 준비하고 있다. 기존 지구 주변 궤도상에 존재하는 우주물체들과 뉴스페이스 우주개발에 따라 생성된 다수의 우주물체들로 인해 하루에도 30회 이상 우주물체 충돌위험상황이 발생하고 있다. 이처럼 막대한 국가 예산을 투입하여 개발한 우주자산들을 안전하게 운영하기 위해 한국항공우주연구원에서는 우주물체 관측, 충돌위험완화, 위성보호, 위성폐기 및 재진입, 우주임무운영, 정책 등의 분야에 대한 현업 및 연구를 수행하고 있으며, 본 발표를 통해 최근 연구 수행 현황 및 향후 계획에 대해 소개하고자 한다.

구두발표 논문 제목 및 시간표

4월 26일(수)

제1발표장 (Convention I)

13:50 [IS-I]

Cross-Scale Processes of Magnetic Reconnection Observed by MMS

Kyoung-Joo Hwang

Southwest Research Institute (SwRI), San Antonio, Texas, USA

14:30 [I-1-1]

Are Physics-Math-Based Iteration Methods and Physics-Informed Neural Network Methods in Static Magnetic Field Calculation More Different or More Similar?

Gwangson Choe[1,2], Sibaek Yi[2], Minseon Lee[1], Mingyu Jeon[2]

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

14:45 [I-1-2]

ROKITS: Space-Borne Wide-Field Auroral/Airglow Imager

Woo Kyoung Lee[1,2], Seonhwan Choi[1], Kyoung-Min Roh[1,2], Young-Sil Kwak[1,2], Jihun Kim[1], Yunjong Kim[1], Jongyeop Park[1], Dukhaeng Lee[1], Tae-Young Yang[1], Jaeheung Park[1,2], Jihye Baek[1], Jong-Kyun Chung[1], Geonhwa Jee[2,3], Hyosub Kil[4], Larry J. Paxton[4]

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

15:00 [I-1-3]

Three-Dimensional Geometry of a Current Sheet in the High Solar Corona: Evidence for Reconnection in the Late Stage of the Coronal Mass Ejection

Ryun Young Kwon

Korea Astronomy and Space Science Institute

15:15 [I-1-4]

Airglows as a Contributing Factor to Reliability of ICON/MIGHTI Winds

Jaewook Lee[1,2], Young-Sil Kwak[1,2], Hosik Kam[1], Hyosub Kil[3], Jeongheon Kim[1], Tae-Yong Yang[1]

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

15:30 [I-1-5]

Multiple Magnetometer-Based Magnetic Noise Cancellation Program for the CAS500-3 Satellite

Cheong-Rim Choi[1], Tongnyeol Rhee[2], Seung-Uk Lee[1], Doo-Young Choi[1], Chang-Ho Woo[3], Kwang-Sun Ryu[3]

[1]*Department of Astronomy and Space Science, CBNU*
[2]*National Fusion Research Institute*
[3]*Satellite Technology Research Center, KAIST*

15:45 [I-1-6]

Statistical Study of Cold Ions Energized by Negative Spacecraft Surface Charging

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

School of Space Research, Kyung Hee University

16:25 [II-1-1]

Development of a Diagnostic Coronagraph on the ISS: CODEX Progress Report

Yeon-Han Kim[1], Seonghwan Choi[1], Su-Chan Bong[1], Kyungsuk Cho[1,2], Jeffrey Newmark[3], Nat. Gopalswamy[3], KASI-NASA Coronagraph Team

[1]*Korea Astronomy and Space Science Institute, Korea*
[2]*University of Science and Technology, Korea*
[3]*NASA Goddard Space Flight Center, USA*

16:40 [II-1-2]

Microwave Brightness Distribution and Its Variation along Flare Loop

Sujin Kim[1], Jeongwoo Lee[2], Su-Chan Bong[1], Satoshi Masuda[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*New Jersey Institute of Technology*
[3]*Nagoya University*

16:55 [II-1-3]

Long-Term Meteor Radar Observations of Upper Mesospheric Winds over King Sejong Station, Antarctica, and Comparison with WACCM Simulations

Byeong-Gwon Song, In-Sun Song

Department of Atmospheric Sciences, Yonsei University

17:10 [II-1-4]

Determination of Three-Dimensional Parameters of Synthetic CMEs by Deep Learning

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

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

17:25 [II-1-5]

Statistical Analysis of Magnetosonic Waves in Plasmaspheric Plumes

Yun-Gi Han, Kyung-Chan Kim

Department of Astronomy and Space Science, Chungbuk National University

17:40 [II-1-6]

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

Se-Heon Jeong[1], Woo Kyoung Lee[1], Soojeong Jang[2], Hyosub Kil[3], Jeong-Heon Kim[1], Young-Sil Kwak[1,4]

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

제2발표장 (Convention II)

14:30 [I-2-1]

Selected Science Topics Utilizing *In-Situ* Observations at Multiple Points near 1 au

Dae-Young Lee[1], Kyung-Eun Choi[2], Ji-Hyeon Yoo[1], Dooyoung Choi[1]

[1]*Chungbuk National University*
[2]*UC-Berkeley, Space Science Laboratory*

15:00 [I-2-2]

On How the Heliospheric Current Sheets within the Inner Heliosheath Differ from Those at 1 AU

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

[1]*Chungbuk National University*
[2]*Space Sciences Laboratory, University of California, Berkeley*

15:15 [I-2-3]

Modeling for Fast Temporal Changes of Energetic Neutral Atom Flux Originating from the Inner Heliosheath

Ji-Hyeon Yoo, Dae-Young Lee

Department of Astronomy and Space Science, Chungbuk National University

15:30 [I-2-4]

Scientific Issues in Consideration of *In Situ* Measurements at the Lagrangian 4 Point and the Inner Heliosphere

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

Korea Astronomy and Space Science Institute

15:45 [I-2-5]

Observing CMEs and SEPs from the Lagrangian 4 Point: Scientific Goals and Detector Requirements

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

Korea Astronomy and Space Science Institute

16:00 [I-2-6]

Selection of EUV Channels for L4 Mission in View of Deep Learning Applications

Hyun-Jin Jeong[1], Yong-Jae Moon[1], Jinhye Park[1], Daye Lim[2], Eunsu Park[3], Harim Lee[1], Daeil Kim[1]

[1]*Kyung Hee University*
[2]*KU Leuven (Belgium)*
[3]*Korea Astronomy and Space Science Institute*

16:25 [II-2-1]

Slitless Imaging Spectrometer and Overlappogram

for L4 Mission

Kyoung-Sun Lee

Seoul National University, Korea

16:40 [II-2-2]

Deploying a Solar Magnetograph for a Future L4 Mission: Objectives and Requirements

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

Korea Astronomy and Space Science Institute

16:55 [II-2-3]

A Review on Pointing Stability Requirements and Attitude Control Implementation Technology for Large Space Telescopes

Hong-Bae Kim

CEO of Dexterous Technology

17:10 [II-2-4]

Mission Design Considerations for a Sun-Earth Lagrange Point L4 Mission

Jae-ik Park[1], Moon-Jin Jeon[1], Donghun Lee[2], Sung-Woo Kim[3], Junga Hwang[4], Kyung-Suk Cho[4]

[1]*Korea Aerospace Research Institute*
[2]*Korea Aerospace University*
[3]*TelePIX Co., Ltd.*
[4]*Korea Astronomy and Space Science Institute*

17:25 [II-2-5]

Dynamics near the Sun-Earth's Fourth Lagrange Point (L4)

Jinsung Lee, Jaemyung Ahn

Korea Advanced Institute of Science and Technology

17:40 [II-2-6]

Pre-Feasibility Study of a Sun-Earth Lagrangian L4 Mission

J. Hwang[1,2], K.-S. Cho[1], E.-K. Lim[1], J.-Y. Han[1], S.-H. Choi[1], J. Seough[1], R.-S. Kim[1], S.-H. Park[1], Y.-S. Kim[1], J.-D. Sohn[1], J.-H, Baek[1], Y.-J. Moon[3], J. Seon[3], K.S. Ryu[4], C.-H, Lee[5]

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

제3발표장 (301호)

14:30 [I-3-1]

Development of the Concept of Operation Using Army Maneuver Space Operation System

Se-Chan Song, Young-bong Jeon

Republi of Korea Army Headquarter

14:45 [I-3-2]

National Defense Space Systems Consisting of Mega Constellation in LEO

Sang Sul Han

Agency for Defense Development

15:00 [I-3-3]

Start Full-Fledged Low Earth Orbit Satellite Communication Service, Use Multi-Layer Network for Military Purposes

Youngwan Cho, Yongwha Lee

Hanwha Systems

15:15 [I-3-4]

Adaptive Optics Real-Time Controller Using High Performance Computing Technology

Seonghwan Choi[1], Byeongchae Bang[2], Jihun Kim[1], Gwanghui Jeong[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*AntBridge, Inc.*

15:30 [I-3-5]

Development Strategy of Small Satellite Launch Vehicle

Dongyoon Shin, Seonghyeon Seo, Eunkwang Lee, Sebum Chun, Daehyun Hwang

Perigee Aerospace Inc.

15:45 [I-3-6]

A Study on Acquring Military Space Launch Facilites

Hyun Joo Choi, Kyeong Keun Kim, In Ho Seo, Minji Bae, Ji Hee Yoo

Agency for Defense Development

16:25 [II-3-1]

Normal Stress Redistribution in Wheel-Soil Interaction of Lunar Rover due to Grouser Tip-Induced Soil Removal

Viet Dinh Le, Yujin Lim, Pierre Anthyme Bahati

Paichai University, Daejeon, South Korea

16:40 [II-3-2]

Active Space Debris Removal Mission: Mission Design and Trajectory Optimization for Protecting Orbital Service of Low Earth Orbit Satellites

Jin Haeng Choi, Chandeok Park

Yonsei University

16:55 [II-3-3]

System Monitoring Data for KMTNet 18k CCD Camera

Sang-Mok Cha, Chung-Uk Lee, Dong-Joo Lee, Dong-Jin Kim, Yongseok Lee, Seung-Lee Kim

Korea Astronomy and Space Science Institute

17:10 [II-3-4]

Strategies for Asteroid Frozen Orbit Design Subject to Dynamics Incorporating Solar Radiation Pressure Models

Jinah Lee, Chandeok Park

Department of Astronomy, Yonsei University

17:25 [II-3-5]

GK2A P-OBT Drift Set Automation Design

Junghyun Lee, Hyunkyu Shin, Sungsik Huh, Sangcherl Lee, Cheolhea Koo

Korea Aerospace Research and Institute

4월 27일(목)

제1발표장 (Convention I)

09:00 [특별강연]

Introduction of 4th Space Development Promotion Basic Plan and Establishing Space Exploration Roadmap

제4차 우주개발진흥 기본계획 및 우주탐사 로드맵 수립 계획 소개

임종빈

과학기술정책연구원 국가우주정책연구센터

09:40 [III-1-1]

Assessment of Ionospheric Ion Velocity Measurements from VIPIR/Dynasonde at Jang Bogo Station, Antarctica

Hyuck-Jin Kwon[1], Geonhwa Jee[1,2], Young-Bae Ham[1,2], Nickolay Zabotin[3], Changsup Lee[1,2], Eunsol Kim[1], Terrence Bullett[3]

[1]*Korea Polar Research Institute*
[2]*University of Science and Technology*
[3]*University of Colorado, Boulder, Colorado, USA*

09:55 [III-1-2]

Effect of Radiative Relaxation on Intensity-Velocity Phase Difference in Umbral Oscillations

Kyeore Lee, Jongchul Chae

Seoul National University

10:10 [III-1-3]

Dynasonde Observations of Ionospheric Polar Holes under Quiet Geomagnetic Conditions at Jang Bogo Station, Antarctica

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

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

10:25 [III-1-4]

A Statistical Analysis of Wave Characteristics between Storm and Non-Storm Periods of Mid-Latitude Pc1 Waves during the 24th Solar Cycle

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Jaehueng Park[1,2], Jiwoo Kim[3], Hyangpyo Kim[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, University of Science and Technology*
[3]*Department of Astronomy, Space Science and Geology, Chungnam National University*
[4]*Space Research Institute (IWF), Graz, Austria*

10:40 [III-1-5]

Investigation Plan of the Degree of Linear Polarization of the Solar F-Corona on the CODEX and the Total Solar Eclipse

Heesu Yang, Su-Chan Bong

Korea Astronomy and Space Science Institute

10:55 [III-1-6]

Chromospheric Umbral Oscillations Driven by the Subphotospheric Resonance of Fast Magnetohydrodynamic Waves

Juhyung Kang[1], Jongchul Chae[1], Kyuhyoun Cho[2,3], Soosang Kang[1], Eun-Kyung Lim[4]

[1]*Seoul National University*
[2]*Bay Area Environmental Research Institute*
[3]*Lockhead Martin Solar and Astrophysics Laboratory*
[4]*Korea Astronomy and Space Science Institute*

11:10 [III-1-7]

Proposal of a New Method for Estimating Mesospheric Gravity Wave Activity Using Specular Meteor Radar

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

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

11:25 [III-1-8]

Verification of the KIDARiM Model's Prediction Results on the Ionosphere over the Korean Peninsula

Jeong-Heon Kim[1], Young-Sil Kwak[1,2], Se-Heon Jeong[1], Daekyu Shin[3], Jongyeon Yun[4], YongHa Kim[5]

[1]*Korea Astronomy and Space Science Institute, KASI*
[2]*University of Science and Technology, UST*
[3]*Space Environment Laboratory, SELab*
[4]*Korea Space Weather Center, KSWC*
[5]*Chungnam National University, CNU*

11:40 [III-1-9]

Alfvén Wave Transport in the Solar Chromosphere and Corona: A Simple Layer Solution

Jongchul Chae, Kyoung-Sun Lee

Seoul National University

13:00 [IV-1-1]

Space Radiation Dosimetry in Low-Earth Orbit: The LEODOS Instrument on Board the NEXTSat-2

Uk-won Nam[1], Won-Kee Park[1], Sukwon Youn[2], Bong-Kon Moon[1], Jongdae Shon[1], Young-Jun Choi[1], Jeonghyun Pyo[1], Jaejin Lee[1], Junga Hwang[1,3], Sunghwan Kim[4], Sung-Joon Ye[2], Hongyoung Park[5], Taeseong Jang[5], Jungho Kim[6]

[1]*Korea Astronomy and Space Science Institute*
[2]*Radiological Physics Laboratory, Seoul National University*
[3]*University of Science and Technology*
[4]*Department of Radiology, Cheongju University*
[5]*Satellite Technology Research Center, KAIST*
[6]*Korea Research Institute of Standards and Science*

13:15 [IV-1-2]

Latitudinal Variations on Thermospheric Winds and Temperatures over Arctic Area under Different Geomagnetic Conditions

Changsup Lee[1,2], Geonhwa Jee[1,2], Qian Wu[3], Young-bae Ham[1,2], Jeong-Han Kim[1], Hyuck-Jin Kwon[1], Jieun Kim[1]

[1]*Korea Polar Research Institute*
[2]*University of Science and Technology*
[3]*NCAR - High Altitude Observatory*

13:30 [IV-1-3]

Forecast of Major Solar Flare Using Deep Reinforcement Learning for Imbalanced Classification

Kangwoo Yi[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[1]

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

13:45 [Ⅳ-1-4]

Preliminary Design of the GrainCams Payload for the Lunar Rover

Woojin Kim[1,2], Bongkon Moon[1,2], Dukhang Lee[1], Dae-Hee Lee[1], Min-Bae Kim[1], Minsup Jeong[1], Jihun Kim[1], Seonghwan Choi[1], Jehyuck Shin[1], Mingyeong Lee[1,2], ChaeKyung Sim[1], Young-Jun Choi[1,2], Sungsoo S. Kim[3]

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

14:00 [Ⅳ-1-5]

A Solar Limb Flare Model Using SDO/AIA EUV Limb Intensity

Jaewon Lee[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[2], Harim Lee[2]

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

14:30 [IS-II]

The Era of Space Economy and the Role of Korea Aerospace Research Institute

Sang-Ryool Lee

Korea Astronomy and Space Science Institute

15:10 [IS-III]

BioCabinet (Bio 3D Printing and 3 Dimensional Culture System) for Space Biomedicine

Chan Hum Park[1,2,3], Young Jin Lee[2], Ji Seung Lee[2]

[1]*Hallym University Medical Center*
[2]*NanoBio Regenerative Medical Institute, Hallym University*
[3]*Otorhinolatyngology-HNC in Chuncheon Sacred Heart Hospital, Hallym University*

제2발표장 (Convention II)

09:40 [III-2-1]

OWL-Net Observations of Near-Earth Asteroid 2023 BU: Physical Properties and Implications for Planetary Defense

Hee-Jae Lee, Myung-Jin Kim, Hong-Suh Yim, Dong-Goo Roh, Jin Choi, Jang-Hyun Park, Young-Sik Park, Jung Hyun Jo, Jaemann Kyeong, Jiwoong Yu, Hong-Kyu Moon, Yoon-Ho Park, Sungki Cho, Eun-Jung Choi

Korea Astronomy and Space Science Institute

09:55 [III-2-2]

Korea Meteor Monitoring and Observation Network (K-M^{2}ONet): Status Update and Modified Data Reduction Process

Yun Hak Kim[1], Dong-Goo Roh[1], Jang-Hyun Park[1], Sungki Cho[1], Jung Hyun Jo[1], Jeong Yoo Hong[1], Hong-Suh Yim[1], Mansoo Choi[1], Myung-Jin Kim[1], Eun-Jung Choi[1], Jin Choi[1], Jiwoong Yu[1], Hee-Jae Lee[1], Jaemann Kyeong[1], Ki pyoung Sung[1], Sung-Yeol Yu[1], Seokmin Song[1,2], SeongHo Son[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungnam National University*
[3]*Open Sky Partners Inc.*

10:10 [III-2-3]

Autonomous Geometric Calibration of All-Sky Camera Using Graph Matching Method

Jang-Hyun Park

Korea Astronomy and Space Science Institute

10:25 [III-2-4]

Real-Time Spatiotemporal Reasoning for Safe and Efficient Space Using AstroLibrary

Shawn SH Choi[1,2,3], Peter JH Ryu[1,2], Chanyoung Song[2,3], Hyunwoo Kim[2,3], Junhee Jang[2,3], Minwoo Ji[2,3], John Kim[1], Lowell Kim[1], Douglas DS Kim[1,2,3]

[1]*SPACEMAP Inc.*
[2]*Voronoi Diagram Research Center, Hanyang University*
[3]*School of Mechanical Engineering, Hanyang University*

10:55 [III-2-5]

Real-Time Conjunction Assessment with Collision Probability and Miss Distance Using AstroFingertip of SPACEMAP

Peter JH Ryu[1,2], Shawn SH Choi[1,2,3], Chanyoung Song[2,3], Hyunwoo Kim[2,3], Junhee Jang[2,3], Minwoo Ji[2,3], John Kim[1], Lowell Kim[1], Douglas DS Kim[1,2,3*]

[1]*SPACEMAP Inc.*
[2]*Voronoi Diagram Research Center, Hanyang University*
[3]*School of Mechanical Engineering, Hanyang University*

11:10 [III-2-6]

Prototype Production for Space Debris Surveillance Radar Technology Development

Jong-Ki Shin[1], Kyung-An Jung[1], Sung-Jae Lee[1], Andrew Chung[1], Sungki Cho[2], Jiwoong Yu[2]

[1]*Kipco Radar & Aerospace*
[2]*Korea Astronomy and Space Science Institute*

11:25 [III-2-7]

Space Object Measurement and Identification Test Results Using Radar Assets of the Republic of Korea Air Force

Jiwoong Yu[1], Sungki Cho[1], Sujin Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Republic of Korea Air Force*

11:40 [III-2-8]

Review of the Monitoring and Observation of the Final Re-Entry Trajectory of ERBS Satellite

Eun-Jung Choi, Jin Choi, Dong-Goo Roh, Yun-Hak Kim, Sungki Cho

Korea Astronomy and Space Science Institute

제3발표장 (301호)

09:40 [III-3-1]

Analysis of Laser Communication Link Budget between Low Earth Orbit Satellites and Ground

Jin Pyong Jung

Korea Aerospace Research Institute

09:55 [III-3-2]

Performance Analysis of PPM Signals Having Finite Extinction Ratios in Free-Space Optical Communication

Jihoon Lee, Hoon Kim

Korea Advanced Institute of Science and Technology

10:10 [III-3-3]

Preliminary Results of Space Optical Communication Experiments

Wonseok Kang[1], Taewoo Kim[1], Sang Hoon Oh[1], Yong-Sun Park[1,2], Jung-Hoon Kim[1,3], Jinil Kang[4], Hyunjoong Son[4]

[1]*Spacebeam, Inc.*
[2]*Seoul National University*
[3]*SETsystem, Inc.*
[4]*BORsys Corp.*

10:25 [III-3-4]

Development of Small Size Space Laser Communication Terminal Prototype

Kiwook Baeck, Paulo Kemper, Hyosang Yoon

Korea Advanced Institute of Science and Technology

10:40 [III-3-5]

Miniaturization of Optical Wireless Communication System for Space Laser Communication

Chan Il Yeo[1], Young Soon Heo[1], Siwoong Park[1,2], Keo Sik Kim[1], Hyung Jun Park[1]

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

10:55 [III-3-6]

Development and Introduction of SLODAR Equipment

Seok Gi Han[1], Seok Young Ju[1], Ji Yong Joo[1], Hyeon Seung Ha[1], Jun Ho Lee[1], Jeon Geon Kang[2], Eui Seung Son[2], Howoo Chiang[3], Ji-young Jung[3]

[1]*Department of Optical Engineering, Kongju National University*
[2]*Defense Industry Technology Center*
[3]*Hanwha Systems*

11:10 [III-3-7]

Implementation and Comparison of LTAO Algorithm Using Learn & Apply Method

Seok Young Ju[1], Seok Gi Han[1], Ji Yong Joo[1], Hyeon Seung Ha[1], Jun Ho Lee[1], Jeon Geon Kang[2], Eui Seung Son[2], Howoo Chiang[3], Ji-young Jung[3]

[1]*Department of Optical Engineering, Kongju National University*
[2]*Defense Industry Technology Center*
[3]*Hanwha Systems*

11:25 [III-3-8]

Ultra-Precision Manufacturing Technology for Freeform Surface Reflective Optics with Optical

Communication Applications

Geon Hee Kim[1,2], Min Soo Yang[1], Young Duk Park[2], Jong Gyun Kang[3], Joong Kyu Ham[4], Young Tae Kwak[4], Seong Hyeon Park[4], Jin Yong Heo[2]

[1]*Department of Defense and Space Engineering, Hanbat University*
[2]*Department of Mechanics-Materials Convergence System Engineering, Hanbat University*
[3]*Department of Mechanical Engineering, Chungnam University*
[4]*Department of Mechanical Engineering, Hanbat University*

11:40 [III-3-9]

Introduction to Convergence Cluster for Technology Development of Space Laser Communication

Hyung-Chul Lim, Mansoo Choi, Sung-Yeol Yu, Ki-Pyung Sung, Jonguk Park, Seonghwan Choi, Jeong-Yeol Han, Ryun-Young Kwon

Korea Astronomy and Space Science Institute

13:00 [IV-3-1]

Statistical Study of Low Energy Ions Originated from the Lunar Dayside in the Terrestrial Magnetotail Lobe

Jaehee Lee[1], Khan-Hyuk Kim[1], Seul-Min Baek[2], Jong-Woo Kwon[1], Ho Jin[1], Jonghoon Lee[1], Ensang Lee[1], Yoshifumi Saito[3], Masaki N. Nishino[4], Shoichiro Yokota[5]

[1]*Kyung Hee University, Korea*
[2]*Korea Astronomy and Space Science Institute*
[3]*Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency*
[4]*Tokyo University, Japan*
[5]*Osaka University, Japan*

13:15 [IV-3-2]

Zero Offset Determination Study of KMAG Aboard KPLO Using MVA Method in the Solar Wind

Hyeonhu Park[1], Ho Jin[1], Kwan-Hyuk Kim[1], Wooin Jo[1], Seul-Min Baek[2], Junhyun Lee[1], Yunho Jang[1]

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

13:30 [IV-3-3]

Stray Light Analysis of Volume-Sharing Multi-Aperture Payload for Earth Observation

Sehyun Seong[1,2], Seonghui Kim[1,2], Jun Ho Lee[3], Myoungjoo Kang[4], Sug-Whan Kim[2]

[1]*TelePIX Co., Ltd.*
[2]*Department of Astronomy, Yonsei University*
[3]*Department of Optical Engineering, Kongju National University*
[4]*Department of Mathematical Sciences, Seoul National University*

13:45 [IV-3-4]

Pre-Flight Calibration and Early Operation Results of PolCam

Minsup Jeong[1], Young-Jun Choi[1,2], Sungsoo S. Kim[3], Bongkon Moon[1], Chae Kyung Sim[1], Kyung-In Kang[4], BonJu-Gu[4]

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

제4발표장 (302호)

09:40 [III-4-1]

The Role of Space in Deterrence

Yungjin Jung

Korea National Defense University

09:55 [III-4-2]

Preliminary Design of GeoKompsat-3 Communications Payload System

Byoung-Sun Lee[1,2], Dongpil Chang[1], Cheon Sig Sin[1]

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

10:10 [III-4-3]

Towards Space Security with SSA and STM Activities of Korea Aerospace Research Institute

Youeyun Jung, Jaedong Seong, Saehan Song, Okchul Jung, Daewon Chung

Korea Aerospace Research Institute

10:25 [III-4-4]

Optical Technology for Secure Space Security of

Among Civilian-Government-Military

Geon Hee Kim[1,2], Min Soo Yang[1], Young Duk Park[2], Jong Gyun Kang[3], Joong Kyu Ham[4], Young Tae Kwak[4], Seong Hyeon Park[4], Jin Yong Heo[2]

[1]*Department of Defense and Space Engineering, Hanbat University*
[2]*Department of Mechanics-Materials Convergence System Engineering, Hanbat University*
[3]*Department of Mechanical Engineering, Chungnam University*
[4]*Department of Mechanical Engineering, Hanbat University*

10:55 [III-4-5]

Global Navigation Service System (GNSS) Signal Interference on Araon Icebreaker

Jong-Kyun Chung, Junseok Hong

Korea Astronomy and Space Science Institute

11:10 [III-4-6]

Orbit Determination of GPS Satellites: Orbit Correction Improvement via TEQC-based Stochastic Modeling of Multipath

Gyumin Kim, Jinah Lee, Jin Haeng Choi, Chandeok Park

Department of Astronomy, Yonsei University

11:25 [III-4-7]

Ionospheric Perturbations by VLF Transmitters for Submarine Communications

Ho-Sung Choi[1], Jaeheung Park[2], Magnus F. Ivarsen[3]

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

4월 28일(금)

제1발표장 (Convention I)

09:00 [V-1-1]

The Impacts of Lower Atmospheric Variabilities on the Ionosphere Using SD-WACCM-X during Two Geomagnetic Storms: April 2010 and March 2013

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

Department of Atmospheric Sciences, Yonsei University

09:15 [V-1-2]

Effect of Ion Drag on Thermospheric Neutral Dynamics during Wintertime in Southern Polar Cap

Young-Bae Ham[1,2], Geonhwa Jee[1,2], Changsup Lee[1,2], Hyuck-Jin Kwon[1], Eunsol Kim[1], Jeong-Han Kim[1], Qian Wu[3], Nikolay Zabotin[4], Terence Bullett[5]

[1]*Division of Atmospheric Sciences, Korea Polar Research Institute*
[2]*Department of Polar Sciences, University of Science and Technology*
[3]*High Altitude Observatory, National Center for Atmospheric Research*
[4]*Department of Electrical and Computer Engineering, University of Colorado Boulder*
[5]*Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder*

09:30 [V-1-3]

The Effect of Transition Region on the Umbral Oscillations

Soo-Sang Kang, Jongchul Chae

Seoul National University

09:45 [V-1-4]

First Observation of the Possible Vertical Coupling between D-Region Convective PMSE Fast Flow and Pulsating Aurora

Young-Sook Lee[1], Yukinaga Miyashita[2,3], Akira Kadokura[4], Ram Singh[1], Young-Sil Kwak[2,3], Yong Ha Kim[1], Mark Lester[5]

[1]*Chugnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*
[4]*National Institute of Polar Research (NIPR), Japan*
[5]*University of Leicester, United Kingdom*

10:00 [V-1-5]

Capella: A Space-Only High-Frequency Radio VLBI Network Formed by a Constellation of Small Satellites

Sascha Trippe

Seoul National University

제2발표장 (Convention II)

09:00 [V-2-1]

Heat Protection for Reentry Vehicle into Earth's Atmosphere

Hyo Keun Ahn

Agency for Defense Development

09:15 [V-2-2]

A Study on the Seasonal, Daily and Geographical Variability of Physical Parameters of Upper Atmosphere between 100-300 Km for Reentry Trajectory Analysis

Gi-Hyuk Choi[1], Won-Seok Lee[2], Dae-Yeong Kim[1]

[1]*Satellite & Space Exploration Systems Engineering and Architecture R&D Divison, Korea Aerospace Research Institute*

[2]*Department of Atmospheric Science, Yonsei University*

09:30 [V-2-3]

Introduction to Guidance Techniques for Reentry Vehicles

Chang-Hun Lee

Korea Advanced Institute of Science and Technology

09:45 [V-2-4]

Statistical Solution Algorithm for Multiscale Gas Flow at All Knudsen Numbers: Hypersonic Reentry Flow

Eunji Jun

Korea Advanced Institute of Science and Technology

10:15 [V-2-5]

Enabling Earth Atmospheric Reentry Missions for Thermal Protection System Technology Demonstration

Hyeonjun Kim[1], Jaesung Shin[1], Daeban Seo[1], Keejoo Lee[1], Beomseok Oh[1], Jaesung Park[1], Sungwon Kim[2]

[1]*Korea Aerospace Research Institute*

[2]*Korea Institute of Ceramic Engineering and Technology*

10:30 [V-2-6]

Atmospheric Entry Flight of Planetary Vehicle and Ground Testing

Jae Jeong Na

Agency for Defense Development

10:45 [V-2-7]

Introduction of the Aerothermodynamic Heating on the Atmospheric Entry Vehicles and It's Related Research Topics

Jae Gang Kim

Sejong University

11:00 [V-2-8]

Fabrication and Characteristics of Porous Ceramic Materials for Reusable TPS Applications

Seongwon Kim[1], Min-Soo Nam[1,2], Yoon-Suk Oh[1], Sahn Nahm[2], Jaesung Shin[3], Hyeonjun Kim[3], Bum-Seok Oh[4]

[1]*Engineering Materials Center, Korea Institute of Ceramic Engineering and Technology*

[2]*Department of Materials Science and Engineering, Korea University*

[3]*Small Launcher R&D Office, Korea Aerospace Research Institute*

[4]*Launcher Thermal and Aerodynamics Team, Korea Aerospace Research Institute*

제3발표장 (301호)

09:00 [V-3-1]

An Introduction of Geostationary Ocean Color Imager System

Geumsil Kang, Jeoung Heum Yeon, Jongguk Choe, Won Beom Lee, Jeeyeon Yoon, Ilseop Lee, HaengPal Heo

Korea Aerospace and Research Institute

09:15 [V-3-2]

GEMS Operation Status and Mission Plan for the Next Environmental Satellite

Jaehoon Jeong[1], Kyung-Jung Moon[1], Dongwon Lee[1], Hanlim Lee[2], Dai-Ho Ko[3]

[1]*National Institute of Environmental Research*

[2]*Pukyoung National University*

[3]*Korea Aerospace Research Institute*

09:30 [V-3-3]

Toward GOCI-III Improvement from the Experiences of GOCI-II

Jae-Hyun Ahn[1], Kyeong-Sang Lee[1], Sun Ju Lee[1], Jong-Kuk Choi[1], Eunna Jang[1], Myung-Sook Park[1], Jeong-Eon Moon[1], Tai-Hyun Han[1], Hee-Jeong Han[1], Joo-Hyung Ryu[1], Geumsil Kang[2], Ki-Beom Ahn[3], Wonkook Kim[4]

[1]*Korea Institute of Ocean Science and Technology*
[2]*Korea Aerospace Research Institute*
[3]*Sirius-K*
[4]*Pusan National University*

09:45 [V-3-4]

R&D and Development Roadmap for Optical Payloads

Sung-Joon Park[1], Gm-Sil Kang[2], Dai Ho Ko[2], Young-Jin Kim[3], Taejung Kim[4], Hagyong Kihm[5], Sehyun Seong[6], Kwangsun Ryu[7], Byung-Geun Lee[8], Hanlim Lee[9], Hyun-Jin Lee[10], Sun Do Lim[5], Seonghwan Choi[1], Jinsuk Hong[11]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Aerospace Research Institute*
[3]*Korea Advanced Institute of Science and Technology*
[4]*Inha University*
[5]*Korea Research Institute of Standards and Science*
[6]*TelePIX Co., Ltd.*
[7]*Satellite Technology Research Center, KAIST*
[8]*Gwangju Institute of Science and Technology*
[9]*Pukyong National University*
[10]*i3system, Inc*
[11]*Hanwha Systems*

포스터발표 논문 제목

4월 27일(목) 15:50~18:00

▶ 우주기술

[P-1] KPLO Flight Software Assessment during Launch Early Operation Phase

Soo-Yeon Kang, Sun-Wook Kim

Korea Aerospace Research Institute

[P-2] Determination of Command Parameters for Payload Operation of NEONSAT

Chiho Kang, Dong-Oh Kim, Daehoon Yoo

Korea Aerospace Research Institute

[P-3] Research on Quantum Communication Systems Applicable to Satellite

Myung-Gil Kim, Kang Toi Yoon, Je Guen Lee

SpaceK Inc

[P-4] Introduction to the Operation Methods of Electrical Ground Support Equipment for Low Orbit Satellite Power Supply

MinJun Kim, Hyunguk Kim, Dong-Chul Chae, Yun-Goo Huh

Korea Aerospace Research Institute

[P-5] Development of an Auxiliary Processing Program for the Automation of Manual Standard Image Processing

SongRan Kim, JunWon Lee, Junyoung Song, Min-A Kim, Guhyeok Kim, MyeongShin Lee

Korea Aerospace Research Institute

[P-6] Technical Considerations on the Test of Focal Point Unit Using Fiber Optic Communication

Young-Yun Kim, Young-Sun Kim, Jong-Pil Gong

Korea Aerospace Research Institute

[P-7] Comparative Analysis of Performance Characteristics of Different Coarse Sun Sensors for Low Earth Orbit Satellite

Yong-Bok Kim

Korea Aerospace Research Institute

[P-8] Introduction of Practical Test Configuration through Integrated Control of Electrical Ground Support Equipment in Low-Orbit Satellites

Jin-Hyuck Kim, Jin-Ho Lee

Korea Aerospace Research Institute

[P-9] Analytical Thermal Path for Improved Design of Spacecraft Radiator

Hui-Kyung Kim[1,2], Choon-Woo Lee[1]

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

[P-10] S-Band Communication Link Consideration for Early Operation of Low Earth Orbit Satellite

Kyun-Sang Park

Korea Aerospace Research Institute

[P-11] GEO-KOMPSAT Bus Operation Evolution

Keun Joo Park, Hyoung Yoll Jun

Korea Aerospace Research Institute

[P-12] Analysis of Electrical Propulsion Thruster Combinations for GEO-KOMPSAT-3

Bong-Kyu Park, Hyoung Yoll Jun, Keun Joo Park

Korea Aerospace Research Institute

[P-13] On-Ground Maintenance of the P-S Configured Flight Model Battery with Inherent BMS Circuitry

Sung-Woo Park[1], Hyung-Jun Jang[2]

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

[P-14] Technoloty Trend of Passive Deorbit System

Eungsik Park, Jonghwi Choi, Keun-Woong Shin

Korea Aerospace Research Institute

[P-15] Electric Propulsion System Configuration for a Public Multi-Purpose Communication

Satellite

Jong Seok Park, Jung Su Choi, Keun Joo Park, Hyoung Yoll Jun

GEO-KOMPSAT-3 Program Office, KARI

[P-16] Orbit Operation Result of CAS500-1

Jong-Oh Park

Korea Aerospace Research Institute

[P-17] Necessity of Establishment an Automation System in Manual Standard Image Processing

Junyoung Song, SongRan Kim, JunWon Lee, Min-A Kim, Guhyeok Kim, MyeongShin Lee

Korea Aerospace Research Institute

[P-18] Generating Code Property Graphs by Analyzing Source Code with Static Analysis

Hyun-Kyu Shin

Korea Aerospace Research Institute

[P-19] An Effective 1553B Scheduling Method through GR1553B

Seung-Eun Yang

Korea Aerospace Research Institute

[P-20] The National Research and Development Innovation Act from the Perspective of a Research Field

Jimo Yang, KeunWoong Shin, JongHwi Choi, EungSik Park

Korea Aerospace Research Institute

[P-21] Gravity Impact Analysis of Large Aperture Hexagonal Segment Mirror for Space Telescope

Jeoung-Heum Yeon, Jongguk Choe, Won-Beom Lee, Su-Young Chang

Korea Aerospace Research Institute

[P-22] Data-Driven Power Generation and Consumption Estimation Model Analysis for Low Earth Orbit Satellites

SeokTeak Yun, Day-Young Kim, Sang-Kon Lee

Korea Aerospace Research Institute

[P-23] Telemetry Monitoring and Contingency System for Low Earth Orbit Satellite

Young-Su Youn[1], Jae-Nam Yu[2]

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

[P-24] Analysis of Radiated Emission EMC Test Results for Satellite System

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

Korea Aerospace Research Institute

[P-25] Assessing the Demand for Frequency Resources to Acquire and Maintain Geostationary Satellite Networks

Seorim Lee

Korea Aerospace Research Institute

[P-26] Development of IAMMAP EQM Model for CAS 500-3

Seunguk Lee[1,2], Kwangsun Ryu[2], Chang-Ho Woo[2], Jinkyu Kim[2], Wonho Cha[2], Dongkook Kim[2], Bon-ju Koo[2], Seong-og Park[2], Dooyoung Choi[1], Cheongrim Choi[1], Dae-Young Lee[1]

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

[P-27] Establish an Interface for Low-Orbit Satellite Standard Image Processing

Jun Won Lee, SongRan Kim, Junyoung Song, Min-A Kim, Guhyeok Kim, MyeongShin Lee

Korea Aerospace Research Institute

[P-28] A Study on the Integrated Multi-Satelllite Download Scheduling System

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

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

[P-29] Fundamental Research on Communicaton Protocols for Standard Space Exploration Vehicles

Hyun-Su Lim

Korea Aerospace and Research Institute

[P-30] A Study on LUTI Images Application Method for *In-Situ* Resource Utilization

Yoon-Jeong Jang

Korea Aerospace Research Institute

[P-31] An Introduction on GK3 Fault Management Preliminary Design Progress

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

Korea Aerospace Research Institute

[P-32] Considerations When Using Absolute Time Command

Dong-Seok Chae

Korea Aerospace Research Institute

[P-33] Development and Initial Experimental Result of the AIMAG EQM for the CAS 500-3

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

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[1]*Korea Aerospace Research Institute*
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Hyeonji Kang[1], Yunho Jang[1], Seungmin Lee[2], Ho Jin[1], Khan-Hyuk Kim[1]

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

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[1]*Korea Astronomy and Space Science Institute*
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Jinhye Park[1], Hyunjin Jeong[2], Yong-Jae Moon[1,2]
[1]*Department of Astronomy and Space Science, Kyung Hee University*
[2]*School of Space Research, Kyung Hee University*

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[1]*School of Space Research, Kyung Hee University*
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Young-Sook Lee[1], Young-Sil Kwak[2,3], Yong Ha Kim[1], Ram Singh[1]
[1]*Chugnam National University*
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Hwanhee Lee[1], Jungjoon Seough[1], Bo Li[2], Yeon-Han Kim[1], Kyung-Suk Cho[1]
[1]*Korea Astronomy and Space Science Institute*
[2]*Institute of Space Sciences, Shandong University*

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

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[1]*Korea Astronomy and Space Science Institute*
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Jo Ryeong Yim, Dong-Gyu Kim

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

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Eunjin Cho[1,2], Young-Jun Choi[1,2]

[1]*Korea Astronomy and Space Science Institute*
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Ik-Seon Hong[1,2], Yu Yi[2]

[1]*Korea Institute of Geoscience and Mineral Resources*
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Seok-Min Song[1,2], Mansoo Choi[1], Yu Yi[2]

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

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Youeyun Jung, Jaedong Seong, Saehan Song, Okchul Jung

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Jun-Ho Kim, Tae-Kyu Jang

Satellite Operation Division, National Meteorological Satellite Center (NMSC)

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Yongseok Lee[1,2], Jongwan Ko[1], Changsu Choi[1], Gyusu Park[1], Youngbeom Jeon[1], Woowon Byun[1], Jaewoo Kim[1], Yunjong Kim[1], Gayoung Lee[1,3], Hyun-Il Sung[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*School of Space Research, Kyung Hee University*
[3]*Department of Astronomy and Atmospheric Sciences, Kyungpook National University*

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Chul Kang

Korea Aerospace Research Institute

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Sung-Hong Park[1], Seonghwan Choi[1], Jihye Baek[1], Eunsu Park[1], Jeongheon Kim[1], Hwanhee Lee[1], Roksoon Kim[1], Jongyeob Park[1], Sujin Kim[1], Young-Sil Kwak[1], Yong-Jae Moon[2], Taeyoung Kim[3]

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

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Korea Aerospace Reasearch Institute

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Jeeyeon Yoon, Jeoung-Heum Yeon, HaengPal Heo

Korea Aerospace Research Institute (KARI) Satellite Payload R&D Division

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Ki-Pyung Sung, Hyung-Chul Lim, Mansoo Choi, Sung-Yeol Yu, Jonguk Park

Korea Astronomy and Space Science Institute

구두발표 논문 초록

4월 26일(수) 제1발표장 Convention I

Invited Talk I

Chair: 민경욱 (과기원)

13:50 [IS-I]

Cross-Scale Processes of Magnetic Reconnection Observed by MMS

Kyoung-Joo Hwang

Southwest Research Institute (SwRI), San Antonio, Texas, USA

The Magnetospheric Multiscale mission (MMS) has captured various physical processes in association with magnetic reconnection that occur over multiple scales from the microscopic to macroscopic scale lengths. Here, significant and novel findings revealed in the near-Earth space since the MMS era are highlighted being categorized into different locations with different magnetic topologies. These potentially paradigm-shifting findings include shock and foreshock transient driven reconnection, magnetosheath turbulent reconnection, flow shear driven reconnection, multiple X-line structures generated in the dayside/flankside/nightside magnetospheric current sheets, development and evolution of reconnection-driven structures such as flux transfer events, flux ropes, and dipolarization fronts, and their interactions with ambient plasmas. Key aspects of kinetic processes leading to multi-scale structures and bringing large-scale impacts of magnetic reconnection as discovered in the geospace environment are emphasized. These key features can be relevant and applicable to understanding other heliospheric and astrophysical systems.

제1발표장 Convention I

I-1 태양 및 우주환경 I

Chair: 권윤영 (천문연)

14:30 [I-1-1]

Are Physics-Math-Based Iteration Methods and Physics-Informed Neural Network Methods in Static Magnetic Field Calculation More Different or More Similar?

Gwangson Choe[1,2], Sibaek Yi[2], Minseon Lee[1], Mingyu Jeon[2]

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

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

Physics and math-based iteration methods have long been investigated and used for computation of static coronal magnetic fields with photospheric boundary conditions obtained from vector magnetograms. Recently there have been attempts to solve these problems using physics-informed neural networks (PINNs). We look into these two types of approaches to find out their similarities and differences. The two approaches have quite a few things in common, especially in that they try to solve an optimization problem with the same constraints. A physics-math-based iterative solver usually presents a straightforward path to lead to a solution. The path leading to an approximate solution in PINNs is non-transparent and the procedure does not necessarily guarantee an output which can meaningfully represent the real solution. It is also to be noted that the words “training” or “learning” are often used in a wrong context in the latter just to endow it with a black-box-like image. However, the latter approach is incomparably more capable than the former in solving inverse problems.

14:45 [I-1-2]

ROKITS: Space-Borne Wide-Field Auroral/Airglow Imager

Woo Kyoung Lee[1,2], Seonhwan Choi[1], Kyoung-Min Roh[1,2], Young-Sil Kwak[1,2], Jihun Kim[1], Yunjong Kim[1], Jongyeop Park[1], Dukhaeng Lee[1], Tae-Young Yang[1], Jaeheung Park[1,2], Jihye Baek[1], Jong-Kyun Chung[1], Geonhwa Jee[2,3], Hyosub Kil[4], Larry J. Paxton[4]

[1]*Korea Astronomy and Space Science Institute*

[2]*University of Science and Technology*

[3]*Korea Polar Research Institute*

[4]*Johns Hopkins University Applied Physics Laboratory*

The Korea Astronomy and Space Science Institute has been developing the ROKITS wide-field auroral/airglow imager, which will be deployed on the Compact Advance Satellite 500-3 set to launch in 2025. The satellite will orbit at an altitude of 600 km with an inclination of 98° (LTAN: 12:40 PM). ROKITS comprises three cameras: two main narrow bandpass filter cameras (3 nm FWHM) and one auxiliary camera without a filter. The main cameras will observe aurora and airglow emissions in two spectral bands (OI 557.7 nm and OI 630.0 nm) with a 90° field of view, providing a swath of over 700 km.

The primary scientific objective of ROKITS is to identify the boundary of the auroral oval and auroral shapes. We will compare ROKITS observations with FUV airglow observations from the DMSP/SSUSI satellite to investigate similarities and differences in auroral boundaries and fine auroral structures between visible and FUV wavelengths. Coincident ground-

based aurora observations using all-sky imagers in collaboration with the Korea Polar Research Institute will help assess ROKITS observations. Furthermore, ROKITS will attempt to detect atmospheric gravity waves by measuring the OI 557.7 nm emission from space. This attempt is a significant endeavor that will provide valuable information on atmospheric gravity waves' behavior and distribution.

15:00 [I-1-3]

Three-Dimensional Geometry of a Current Sheet in the High Solar Corona: Evidence for Reconnection in the Late Stage of the Coronal Mass Ejection

Ryun Young Kwon

Korea Astronomy and Space Science Institute

Motivated by the standard flare model, ray-like structures in the wake of coronal mass ejections (CMEs) have been often interpreted as proxies of the reconnecting current sheet connecting the CME with the postflare arcade. We present the three-dimensional properties of a post-CME ray derived from white light images taken from three different viewing perspectives on 2013 September 21. By using a forward modeling method, the direction, cross-section, and electron density are determined within the heliocentric distance range of 5–9 solar radii. The width and depth of the ray are 0.42 ± 0.08 solar radii and 1.24 ± 0.35 solar radii, respectively, and the electron density is (2.0 ± 0.5) × 104 cm^{-3}, which seems to be constant with height. Successive blobs moving outward along the ray are observed around 13 hr after the parent CME onset. We model the three- dimensional geometry of the parent CME with the Gradual Cylindrical Shell model and find that the CME and ray are coaxial. We suggest that coaxial post-CME rays, seen in coronagraph images, with successive formation of blobs could be associated with current sheets undergoing magnetic reconnection in the late stage of CMEs. This work has been published as Kwon et al. (2016) ApJ, 826, 94.

15:15 [I-1-4]

Airglows as a Contributing Factor to Reliability of ICON/MIGHTI Winds

Jaewook Lee[1,2], Young-Sil Kwak[1,2], Hosik Kam[1], Hyosub Kil[3], Jeongheon Kim[1], Tae-Yong Yang[1]

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

The Michelson Interferometer for Global High resolution Thermospheric Imagine (MIGHTI) on board the Ionospheric Connection Explorer (ICON) satellite has measured neutral winds with limb-scanning using the OI green line (557.7 nm, 88 km–300 km) since November 2019. Neutral winds measured by MIGHTI are very useful information for studying the dynamics in the thermosphere and mesosphere. Therefore, the reliability of the observed wind information is also important. Meanwhile, the Korea Astronomy and Space Science Institute (KASI) has been operating a meteor radar (MR) in Gyeryong (36.18N, 127.14E) since 2017 and has been measuring neutral winds at an altitude of 80–100 km from it. Since the wind measured by MR is close to the true value, we compared the two winds measured by MIGHTI and KASI-MR at 91 km and 94 km from 2020 to 2021 to confirm the reliability of the wind measured by MIGHTI. As a result, the MIGHTI wind and the MR wind were generally similar at night, but there was a significant discrepancy between the two during the day. In order to understand the cause of this difference in reliability between daytime and nighttime, we investigated the maximum altitude and slope of the green-line airglow. That is, the effect of airglow on the limb scan becomes one factor contributing to the discrepancy between the MIGHTI wind and the KASI-MR wind. Therefore, especially when using the daytime MIGHTI wind, we should be aware that the influence caused by this factor is included and pay special attention to its use.

15:30 [I-1-5]

Multiple Magnetometer-Based Magnetic Noise Cancellation Program for the CAS500-3 Satellite

Cheong-Rim Choi[1], Tongnyeol Rhee[2], Seung-Uk Lee[1], Doo-Young Choi[1], Chang-Ho Woo[3], Kwang-Sun Ryu[3]

[1]*Department of Astronomy and Space Science, CBNU*
[2]*National Fusion Research Institute*
[3]*Satellite Technology Research Center, KAIST*

The CAS500-3 satellite, aimed for launch in October 2025, is being developed for the purpose of space science and technology verification. This satellite will be equipped with the IAMMAP (Ionospheric Anomaly Monitor by Magnetometer and Plasma-probe) payload, which is designed to monitor ionospheric disturbances. To enhance the accuracy of magnetic observation, a magnetic noise cancellation program utilizing multiple magnetometers is being developed. This paper presents an overview of the magnetic noise cancellation program and provides examples of its effectiveness in removing magnetic noise.

15:45 [I-1-6]

Statistical Study of Cold Ions Energized by Negative Spacecraft Surface Charging

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

Ho Jin

School of Space Research, Kyung Hee University

We have studied the characteristics of three major ion species (H^+, He^+, and O^+) energized by negative spacecraft charging. We identified 64 events with a minimum spacecraft potential less than −10 V for 23 months (January 2013 to November 2014) by using data obtained from the Van Allen Probes. All events were observed outside the plasmapause in the postmidnight sector (MLT = 0–6) during substorm activity. When the satellite is negatively charged, the cold (< 1 eV) ions are energized to the level of spacecraft charging. They are believed to be energized by the electrostatic field generated by the negative spacecraft charging. Our analysis suggests that ion composition contains an H^+:O^+:He^+ order of dominance. We examine the contribution of H^+ and heavy ion species (He^+, and O^+) to the background plasma. In addition, we also examine the energized cold ions' densities, composition, and pitch angle distributions.

제2발표장 Convention II

I-2 SS: Open New Horizon with L4 Mission I

Chair: 황정아 (천문연)

14:30 [I-2-1]

Selected Science Topics Utilizing *In-Situ* Observations at Multiple Points near 1 au

Dae-Young Lee[1], Kyung-Eun Choi[2], Ji-Hyeon Yoo[1], Dooyoung Choi[1]

[1]*Chungbuk National University*

[2]*UC-Berkeley, Space Science Laboratory*

Near 1 au observations at multiple points such as L4 and L5 as well as L1 are critical for improving our understanding of detailed solar wind structure (e.g., magnetic flux ropes, shocks, other discontinuities, pressure pulses, large-scale Alvenic fluctuations) which actually affects the Earth's magnetosphere. Such observations are also useful and desired for in-depth study on interaction between solar wind and local interstellar medium particles that penetrate into the heliosphere. This talk is intended to contribute to the L4 mission design, which is currently under consideration by Korean solar and space science community, by introducinga few selected topics that can be promising for future studies based on observations at L4, L5 as well as L1, hoping all available in near-future. They include (i) precise determination of spatial structure of small scale flux ropes which are frequently seen in the solar wind and often geoeffective, (ii) modeling of SW velocity and density distribution as a function of longitude by extending the existing IPS-based SW model -- currently available only as a function of latitude, which is closely related to the merged interaction region (an evolved multi-CMEs into a merged larger-scale one), and (iii) seasonal dependence of interstellar pickup ions (PUIs) including heavy ions such as He^+ and others, that is, longitudinal dependence of PUIs relative to interstellar in-flow direction. A few other topics will also be remarked if time is allowed. All these will benefit greatly from multiple observations near 1 au.

15:00 [I-2-2]

On How the Heliospheric Current Sheets within the Inner Heliosheath Differ from Those at 1 AU

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

[1]*Chungbuk National University*

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

In this study, we analyzed the heliospheric current sheet (HCS) within the inner heliosheath (IHS) using the magnetic field and plasma data from Voyager 2. Due to large uncertainty of the Voyager 2 data within the IHS, we only selected HCS in which the polarity of the magnetic field clearly changed. To investigate the effect of the solar cycle on the HCS in the IHS, we examined the yearly occurrence rate of the HCS and compared it with the HCS model on the Sun. We further compared the periodicity of the magnetic field polarity variation in IHS with that at 1AU. In addition, we performed a minimum variance analysis (MVA) for the identified HCS in IHS to estimate its thickness and tilt angle from the solar equatorial plane. In addition, we investigated the merged interaction region (MIR) that existed during the observation interval of the HCS and originated from merging of multiple ICMEs in supersonic solar wind. Lastly, a summary will be given about the properties of the magnetic field and plasma flow within the current sheet.

15:15 [I-2-3]

Modeling for Fast Temporal Changes of Energetic Neutral Atom Flux Originating from the Inner Heliosheath

Ji-Hyeon Yoo, Dae-Young Lee

Department of Astronomy and Space Science, Chungbuk National University

All-sky Energetic Neutral Atom (ENA) maps provided by the Interstellar Boundary Explorer (IBEX) have allowed us to give a chance to deeply understand the interaction between the sun and very local interstellar medium since 2009. According to the ENA maps, heliospheric ENA structure appears as a superposition of globally distributed ENA flux (GDF) and the newly

discovered so-called "IBEX ribbon" that is characterized by an enhanced flux in a nearly-circular narrow zone. Since the GDF has been mostly known as ENAs originating in the inner heliosheath, the study on these GDF ENA observations helps us to understand various mechanisms occurring there. However, there are still many uncertainties and questions about how different ion species physically evolve before they are charge-exchanged with neutrals while traveling from interplanetary space to the termination shock and beyond. To alleviate such difficulties, we investigate how ENAs are observed after charge exchange with interstellar neutrals by adopting two possible combinations of ion distributions in the inner heliosheath. The first of two cases assumes kappa distribution for solar wind protons and reflected pickup ions (PUIs) and filled-shell distribution for transmitted PUIs. The other case assumes kappa distribution for all three species. The different species are given different temperature descriptions in the heliosheath, which is in turn controlled as a function of upstream solar wind conditions. In particular, we focus on examining how sensitively the ENA fluxes from both models change in response to changes of the solar wind conditions at a time resolution of the Carrington rotation period which is faster than IBEX's time resolution of 6 months. We report the specific results of this analysis done for roughly 3 solar cycle periods. We expect that the results will be utilized with ENA observations by Interstellar Mapping and Acceleration Probe (IMAP) or other satellites to be launched in future.

15:30 [I-2-4]

Scientific Issues in Consideration of *In Situ* Measurements at the Lagrangian 4 Point and the Inner Heliosphere

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

Korea Astronomy and Space Science Institute

The multiple observations of the Sun-Earth L1, L4, and L5 Lagrange points at 1 AU could help us improve our understanding of the underlying physics responsible for the variability in space weather environment. Among the scientific payloads, in situ instruments provide the crucial information to link the global evolution of solar wind as well as solar eruptive phenomena to its local feature in the small-scale structure. Here, we introduce the past and present researches into the multi-scale nature of solar wind based upon in situ measurements and plasma theory. They include (i) the origin of distinctive signatures which deviate from a Maxwellian velocity distribution function for both solar wind ions and electrons, (ii) an understanding of the origin and physical processes of small-scale plasma waves that are frequently observed in the interplanetary medium, (iii) modeling of thermodynamic evolution of solar wind, which could help us improve a detailed understanding of interplay between the multi-scale nature and the observed kinetic features of the solar wind. We present a review of the above-mentioned topics that can be promising for present and future missions.

15:45 [I-2-5]

Observing CMEs and SEPs from the Lagrangian 4 Point: Scientific Goals and Detector Requirements

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

Korea Astronomy and Space Science Institute

Solar explosions such as flares and coronal mass ejections (CMEs) affect not only the space around Earth but also the polar and high-latitude regions, causing magnetic storms, precipitation of energetic particles, and ionospheric disturbances, all of which can impact human and modern technology. Furthermore, as we explore beyond the Sun-Earth system to the Moon and Mars, continuous research and monitoring of CMEs and the resulting particle acceleration in the solar corona and interplanetary space, as well as the solar wind are crucial to prepare for and minimize potential hazards. In this respect, observing from the Lagrangian 4 (L4) point provides a significant advantage in allowing direct observation of the solar western hemisphere, which cannot be seen directly from Earth, despite its magnetic field being directly connected to the Earth. In this presentation, we define the scientific goals of the L4 mission related to CMEs and solar energetic particles. In addition, we discuss the detectors, especially the compact coronagraph, and their specifications required to achieve these goals.

16:00 [I-2-6]

Selection of EUV Channels for L4 Mission in View of Deep Learning Applications

Hyun-Jin Jeong[1], Yong-Jae Moon[1], Jinhye Park[1], Daye Lim[2], Eunsu Park[3], Harim Lee[1], Daeil Kim[1]

[1]*Kyung Hee University*
[2]*KU Leuven (Belgium)*
[3]*Korea Astronomy and Space Science Institute*

We have successfully demonstrated the image translation among solar satellite images. First, we have generated solar farside magnetograms from STEREO EUV observations by our deep learning models. We have used the image-to-image translation models based on conditional generative adversarial networks, e.g., Pix2Pix, Pix2PixHD, and Pix2PixCC. We have shown that our artificial intelligence (AI)-generated solar farside

magnetograms can be applied to study the active region evolution over the solar surface and a part of the boundary conditions for the coronal magnetic field extrapolations. Second, we have compared image translations among the nine channels of the Atmospheric Imaging Assembly (AIA) on board the SDO using the Pix2Pix model. The model with 131, 1600, and 304 Å has the highest average CC (0.97). Interestingly, they represent coronal, upper photospheric, and chromospheric channels, respectively. Third, we have generated solar UV and EUV images from solar magnetograms using SDO data sets by the Pix2Pix model. Now we are studying how to select EUV channels for L4 (L5) mission in view of deep learning applications. We consider several combinations (e.g., magnetogram, 195 Å, and another) of EUV channels in view of the generation of other ones and the construction of DEM (differential emission measure). Finally, we discuss the feasibility of these candidates for the L4 (L5) mission in view of deep learning applications.

제3발표장 301호

I-3 안보우주 I

Chair: 최호성 (육군)

14:30 [I-3-1]

Development of the Concept of Operation Using Army Maneuver Space Operation System

Se-Chan Song, Young-bong Jeon

Republi of Korea Army Headquarter

The importance of the space domain in future terrestrial warfare is increasing day by day. The Army is developing the concept of operational management of the Army's maneuver space operation system to carry out future-oriented military space operations. This concept was developed by benchmarking the mission and equipment of the U.S. SMDC (Space Missile Defense Command) ARSST (Army Space Support Team) to study and develop the applicable methods for the Korean Army. As a future study, it will present specific plans for the establishment of a unit and acquisition of a weapons system.

14:45 [I-3-2]

National Defense Space Systems Consisting of Mega Constellation in LEO

Sang Sul Han

Agency for Defense Development

National defense space systems for communications and earth monitoring consisting of mega constellation in Low Earth Orbit (LEO) have been gaining worldwide interest in recent. While not only technology development but also investment in commercial field are being made, interest in national defense field is increasing and military only systems are being proposed. National Defense Space Architecture (NDSA) of the United States is evaluated as a representative example of leading a new space in national defense, and in particular, it is encouraging the participation of many United States companies by promoting a roadmap for phased early force deployment using proven commercial technology. In Korea, this kinds of systems are also necessary to secure short-term achievements and long-term technology development for LEO satellites and national defense space systems.

15:00 [I-3-3]

Start Full-Fledged Low Earth Orbit Satellite Communication Service, Use Multi-Layer Network for Military Purposes

Youngwan Cho, Yongwha Lee

Hanwha Systems

In 2016, Starlink (USA) began the launch of two test satellites to initiate a broadband internet service using low earth orbit communication satellites, and three years later, OneWeb (UK) the second global low earth orbit satellite communication company, launched six test satellites, marking the beginning of full-fledged space internet services. Each company conducted tests of various services such as space internet, video conferencing, and IoT using high-speed communication and low latency through low-earth orbit communication satellites.

Subsequently, they have built satellite constellations for global services. As of March 2023, Starlink has 3,462 active satellites in four inclined orbit planes and OneWeb has 582 active satellites in polar orbit planes.

It is expected that Starlink and OneWeb, which are operating normally, will begin full-fledged Korean services starting from the second half of 2023.

This presentation proposes a feasible plan for establishing a low-earth orbit satellite communication network that can be utilized by the Korean military, as the peninsula service is officially launched. Through the established low-earth orbit satellite communication network, various military applications such as military communication, unmanned aerial vehicles, drone bots, military internet, and the like, can be effectively utilized, similar to the low earth orbit satellite communication services in the Ukrainian war.

15:15 [I-3-4]

Adaptive Optics Real-Time Controller Using High Performance Computing Technology

Seonghwan Choi[1], Byeongchae Bang[2], Jihun Kim[1], Gwanghui Jeong[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*AntBridge, Inc.*

Adaptive optics (AO) is a technology to correct for the effects of atmospheric turbulence or optical aberrations. AO systems are composed of a wavefront sensor (WFS), a deformable mirror (DM), and a real-time controller (RTC). The RTC is responsible for measuring the distortions in the incoming wavefront from WFS and controolling actuators of the DM to correct aberations of atmosphere and opticcal components. It works as a brain of the AO system. Digital Signal Processor (DSP) and Field-Programmable Gate Array (FPGA) have been traditionally used as an RTC platform. It is not easy to find and solove problems in development and operation phases on these kind of platfoms. So we developed the AO RTC based on Central Processing Unit (CPU) platform. We applied parallel computing technology to get high speed computation, and PCIe inteface with optics fiber to get high speed data communication and low latency. The prototype AO RTC we developed supports thousnads of Hz performance for the entire process from receiving WFS image to controlling DM actuators. Because it provides scalable perormance and high compatibility to various kinds of WFS and DM, it can be applied to not only astronomical telescope but also laser communication, medical, and military applications.

15:30 [I-3-5]

Development Strategy of Small Satellite Launch Vehicle

Dongyoon Shin, Seonghyeon Seo, Eunkwang Lee, Sebum Chun, Daehyun Hwang

Perigee Aerospace Inc.

Perigee has been developing a micro space launch vehicle called 'Blue Whale 1' since 2018. Initially, BW1 was designed as a 2 ton vehicle capable of carrying a 50 kg payload to 500 km Sun-synchronous orbit. Challenging technologies such as a cryo-composite tank and methane ORSC engine were considered to realize high performance in such a small size. However, to attain more economic feasibility and to respond to the demand for larger satellites, the final configuration has been set to have a GTOW of 20 ton, and the first stage has been designed to be reusable. Also, a GG cycle methane engine was adopted for cost efficiency and reliability. During this session, the key design features, the realization strategy, and the future launch plans of the BW1 are presented.

15:45 [I-3-6]

A Study on Acquring Military Space Launch Facilites

Hyun Joo Choi, Kyeong Keun Kim, In Ho Seo, Minji Bae, Ji Hee Yoo

Agency for Defense Development

Launching rockets into space, running space launch facilities, and achieving superiority in space requires lot of expertise in various fields. Location of the launch site should meet to minimize hazards from launching and its preparation while its geolocation be effective in launching out from the site. Accessibility, protection from hostile attacks and security should also be considered as a military base. Considerations on how to operate the facilities also requires attention. While launch facilities that are operated for sole military purposes can be considered, time and cost for training and recruiting personnel for achieving operational standard can be ineffective. A more efficient approach, facilities provided by the military and retaining authority for planing and approving launches while work that requires expertise done by contractors can be considered.

제1발표장 Convention I

II-1 태양 및 우주환경 II

Chair: 김수진 (천문연)

16:25 [II-1-1]

Development of a Diagnostic Coronagraph on the ISS: CODEX Progress Report

Yeon-Han Kim[1], Seonghwan Choi[1], Su-Chan Bong[1], Kyungsuk Cho[1,2], Jeffrey Newmark[3], Nat. Gopalswamy[3], KASI-NASA Coronagraph Team

[1]*Korea Astronomy and Space Science Institute, Korea*
[2]*University of Science and Technology, Korea*
[3]*NASA Goddard Space Flight Center, USA*

The Coronal Diagnostic Experiment (CODEX) is a KASI-NASA joint project to develop a diagnostic coronagraph on the ISS, which is designed to obtain simultaneous measurements of the electron density, temperature, and velocity using multiple filters in the 2.5−10 Rs range. The KASI is in charge of developing the flight models of KASI subsystems; focal plane assembly (FPA), filter wheel assembly (FWA), and mechanism control electronics (MCE) which controls the FWA and aperture door of the coronagraph. In August 2022, we had completed the flight models of KASI hard-wares and delivered them to the Goddard Space Flight Center (GSFC). The KASI is also responsible for developing the CODEX control electronics

(CCE), the flight software, and ground operating software. After the delivery of KASI hard-wares, we have continuously supported CODEX assembly, integration, and test. Recently, the CODEX launch was delayed to the middle of 2024, which was originally planned at the end of 2023. In this presentation, we will introduce recent progress and future plan.

16:40 [II-1-2]

Microwave Brightness Distribution and Its Variation along Flare Loop

Sujin Kim[1], Jeongwoo Lee[2], Su-Chan Bong[1], Satoshi Masuda[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*New Jersey Institute of Technology*
[3]*Nagoya University*

We have studied microwave brightness distribution along a flare loop associated with X1.0 flare which occurred in 2013 October 28. The microwave maps are obtained with the Nobeyama Radioheliograph (NoRH) at 17 GHz and 34 GHz and hard X-ray maps are obtained from the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI). EUV images from the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO) were also studied for the context. Total six peaks of the bursts are counted during microwave flare and a dominant microwave source appears to be dynamically changing its position within a simple loop oriented north-south near the limb. On the other hands, during the first three microwave flux peaks, the dominant source appears in the south while the X-ray source lies in the northern end of the loop, while the other three peaks show the opposite trend that the dominant microwave source at the time of the peaks appears in the northern end while the X-ray source lies in the southern end of the loop. Based on the intensity variation, we argue that the northern source is due to the precipitating high-energy electrons and the southern source is due to the trapped electrons, and we discuss the possible cause of the change of the nonthermal source position during the flare.

16:55 [II-1-3]

Long-Term Meteor Radar Observations of Upper Mesospheric Winds over King Sejong Station, Antarctica, and Comparison with WACCM Simulations

Byeong-Gwon Song, In-Sun Song

Department of Atmospheric Sciences, Yonsei University

Long-term characteristics of the horizontal wind in the mesosphere and lower thermosphere (MLT; z = 80–100 km) over King Sejong Station (KSS), Antarctica are investigated using recent 15-year (2007–2021) meteor radar observations. The amplitude and seasonal variabilities of the observed MLT winds at KSS are generally consistent with the well-established climatology at Southern Hemisphere high latitudes. The short-period oscillations (periods of 2 hours-10 days) of the MLT winds, including atmospheric tides and several planetary wave components (such as quasi-2-, 4, 6, 7, and 10-day waves), are examined for each month. To investigate the long-period oscillations (periods > 2 months) in the MLT winds, spectral analysis is conducted using the monthly averaged wind data. Annual and semiannual oscillations of the horizontal wind are distinct below and above z = 90 km, respectively. The long-term trend of the observed zonal wind is estimated using a multiple linear regression model. Statistically significant positive trends of the zonal wind appear above z = 90 km in July, with a range of 0.5–0.8 m s^{-1} yr^{-1}. To understand the observed MLT wind trends, the gravity-wave drag (GWD) in the MLT region is estimated from the meteor radar observations based on the matrix-inversion method proposed in Hocking (2005). The seasonal variability of the long-term trend of the zonal GWD is similar to that of the zonal MLT winds, especially above z = 94 km, implying that the positive zonal wind trends in July are associated with the positive zonal GWD trends in the season. The wind observations using the meteor radar are compared with the specified dynamics version of the Whole Atmosphere Community Climate Model (SD-WACCM) simulation. The observed eastward winds near the mesopause in winter are not well reproduced by the WACCM. In addition, different structures of the short- and long-period components of the MLT winds in observation and simulation will be discussed.

17:10 [II-1-4]

Determination of Three-Dimensional Parameters of Synthetic CMEs by Deep Learning

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

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

In this study, we present a new method to determine three-dimensional parameters of coronal mass ejections (CMEs) using convolutional neural network (CNN) methods, a commonly used deep learning algorithm in image recognition. As the first step, we apply CNN models to synthetic CME images. A synthetic CME image is generated by a full ice-cream cone model for given three-dimensional parameters (radial height, angular width, latitude, longitude). The CNN models are developed based on VGG network and Residual network. We generate 391,000 synthetic CME images with different three-dimensional parameters: 312,800 for training, 39,100 for validation, and 39,100 for test. For the test dataset, we estimate root mean square errors between three-dimensional parameters

of the test dataset and those from CNN models. The best results are 0.4 R_s for radial height, 2.3° for angular width, 0.8° for latitude, and 1.5° for longitude. In future work, we are applying our model to SOHO/LASCO CME observations.

17:25 [II-1-5]

Statistical Analysis of Magnetosonic Waves in Plasmaspheric Plumes

Yun-Gi Han, Kyung-Chan Kim

Department of Astronomy and Space Science, Chungbuk National University

Magnetosonic waves, also known as equatorial noise, are whistler-mode emissions distributed near the Earth's magnetic equator between the proton cyclotron frequency and the lower hybrid resonance frequency. So far, much effort has been devoted to improving our understanding of their origin and characteristics inside and outside the plasmasphere, owing to their potential role in scattering energetic electrons and protons. In contrast, their characteristics in plasmaspheric plumes have not been reported yet. In this study, we, for the first time, statistically investigate magnetosonic waves in the plasmaspheric plumes based on the entire mission period (the year 2012–2019) of Van Allen Probes A and B. Statistical results show that magnetosonic waves are observed in plumes with an occurrence rate of ~10–20% depending on geomagnetic activity. Their amplitude and wave normal angle are distributed with an average of ~40 pT and 84°–88°, respectively. Increased geomagnetic activity enhances the amplitude and the ratio of plasma frequency to electron cyclotron frequency. In addition, approximately 80% of all selected magnetosonic wave events are observed simultaneously with the plasmaspheric hiss, which is known to be most effective in scattering electrons in the plume.

17:40 [II-1-6]

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

Se-Heon Jeong[1], Woo Kyoung Lee[1], Soojeong Jang[2], Hyosub Kil[3], Jeong-Heon Kim[1], Young-Sil Kwak[1,4]

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

The Global Navigation Satellite System (GNSS) provides total electron content (TEC), an essential parameter for understanding the ionosphere phenomenon. Given the impact of the ionosphere on communications and navigation system, accurate and timely TEC prediction is crucial. This study aims to develop a deep learning model for predicting the regional ionospheric TEC map in the vicinity of the Korean Peninsula (26°–40.5°N, 120.5°–135°E) for the next twenty-four hours using convolution long short-term memory (ConvLSTM) and LSTM techniques. We use TEC maps generated by the Deep Convolutional Generative Adversarial Network – Poisson Blending model (Jeong et al. 2022). The training data range from 2002 to 2018; the test period is set to 2019. We compare the model results with observations to evaluate the prediction model's performance.

제2발표장 Convention II

II-2 SS: Open New Horizon with L4 Mission II

Chair: 선종호 (경희대)

16:25 [II-2-1]

Slitless Imaging Spectrometer and Overlappogram for L4 Mission

Kyoung-Sun Lee

Seoul National University, Korea

Observations from various perspectives of the sun and space environment are necessary for forecasting solar activity and space weather changes. Recently, the importance of missions placing satellites at the L4 and L5 positions for observation has been highlighted. In this presentation, we introduce a slitless imaging spectrometer in the EUV wavelength range and its analysis method called overlappogram as a candidate instrument to be installed on a satellite at the L4 position. The slitless imaging spectrometer can provide both imaging and spectrum data over an extended field of view simultaneously, allowing for observation of a large area with a fast time cadence. This advantage can supplement the drawbacks of time resolution and limited FOV, which are considered shortcomings of conventional scan-based imaging spectrometers, and is suitable for obtaining spectroscopic observations of full-sun solar activity and developing solar activity forecasting models. However, since it is a slitless spectrometer, it has lower spectral resolution and spatial resolution than previous instruments in order to obtain images of the full sun. In this presentation, we will briefly introduce recent spectrometers and compare the advantages and disadvantages of slitless imaging spectrometers. We will also discuss the points where the slitless imaging spectrometer is needed for the L4 mission.

16:40 [II-2-2]

Deploying a Solar Magnetograph for a Future L4

Mission: Objectives and Requirements

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

Korea Astronomy and Space Science Institute

The Sun-Earth Lagrange point L4 lies in the Earth's orbit around the Sun at 60 degrees ahead of the Earth. As L4 is a gravitationally stable point, it can be used as a long-term parking lot for spacecrafts to carry out uninterrupted solar and heliospheric observations. In particular, an imaging instrument from L4 is able to cover the Sun's regions in its field-of-view, which possess a high potential to produce Earth-directed energetic particles. Taking into account such unique advantages of L4, we studied what kind of science can be done with a solar magnetograph aiming to obtain full-disk images of the photospheric magnetic field vector with a spatial resolution of $\leq$ 2 arcsec and a cadence of $\leq$ 30 min. One of the key science topics considered is to understand physical processes that generates energetic particles in the solar atmosphere and drives/confines their transient ejection into the heliosphere, analyzing the characteristics and evolution of the magnetic field in their source and background regions. The capabilities and practical application of the magnetograph at L4 will be also discussed, including a stereoscopic removal of the 180-degree ambiguity in the orientation of the transverse magnetic field based on multi-viewpoint observations from other Lagrange points L1 and L5.

16:55 [II-2-3]

A Review on Pointing Stability Requirements and Attitude Control Implementation Technology for Large Space Telescopes

Hong-Bae Kim

CEO of Dexterous Technology

Unlike ground observation satellites, space telescopes that observe deep space is required long time exposure (300-1,000 sec) under extremely stable pointing stability (20 Milli-arc seconds).

With an analysis of pointing stability requirements for space telescopes such as Supernova Acceleration Probe (SNAP), EUCLID under development at ESA, and Solar Dynamics Observatory (SDO) that was put into orbit in 2010 and is still in operation. Attitude control technologies to realize very hard requirements are reviewed.

17:10 [II-2-4]

Mission Design Considerations for a Sun-Earth Lagrange Point L4 Mission

Jae-ik Park[1], Moon-Jin Jeon[1], Donghun Lee[2], Sung-Woo Kim[3], Junga Hwang[4], Kyung-Suk Cho[4]

[1]*Korea Aerospace Research Institute*

[2]*Korea Aerospace University*

[3]*TelePIX Co., Ltd.*

[4]*Korea Astronomy and Space Science Institute*

TThis study examines the mission design considerations for a Sun-Earth Lagrange point L4 mission. The L4 Lagrange point is a stable position in space where the gravitational forces of two large bodies, such as the Earth and the Sun, balance each other and allow a small object to maintain its position relative to them. The L4 is one of the five Lagrange points in the Sun-Earth system. It has been considered a unique place for observing solar activity and the heliospheric environment continuously and comprehensively. In this study, we investigated and analyzed existing mission design cases for the L4 and L5 points. We also examined Korea's first lunar orbiter, Danuri's bus system, and the possibility of using Korea's next-generation launch vehicle for the L4 mission design. We expect that our results will provide valuable insights for conducting a feasibility study and designing a detailed plan for the L4 mission.

17:25 [II-2-5]

Dynamics near the Sun-Earth's Fourth Lagrange Point (L4)

Jinsung Lee, Jaemyung Ahn

Korea Advanced Institute of Science and Technology

The Sun-Earth L4 region is a dynamically complex area of space where gravitational forces from the Sun and Earth balance out, creating a stable point in space. In recent years, this region has gained significant interest due to the presence of natural objects, such as asteroids and dust, as well as the placement spacecraft. This paper provides an overview of the dynamics of natural and artificial objects in the vicinity of the Sun-Earth L4 region. We begin by discussing the characteristics of this region and the factors that contribute to its stability. We then explore the behavior of natural objects in this region, including their orbits, potential collisions, and the effects of solar radiation pressure. We also consider the challenges associated with navigation to the L4 region. Finally, we discuss the implications of these dynamics for future space exploration and scientific missions. We highlight the importance of understanding the behavior of natural and artificial objects in the Sun-Earth L4 region for space situational awareness, space whether and for optimizing the design of future spacecraft and missions.

17:40 [II-2-6]

Pre-Feasibility Study of a Sun-Earth Lagrangian

L4 Mission

J. Hwang[1,2], K.-S. Cho[1], E.-K. Lim[1], J.-Y. Han[1], S.-H. Choi[1], J. Seough[1], R.-S. Kim[1], S.-H. Park[1], Y.-S. Kim[1], J.-D. Sohn[1], J.-H, Baek[1], Y.-J. Moon[3], J. Seon[3], K.S. Ryu[4], C.-H, Lee[5]

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

It is expected that a Sun-Earth Lagrangian L4 mission will significantly advance heliophysics science, improve the capability of space weather forecasting, and extend space weather studies far beyond near-Earth space. A pre-feasibility study conducted by KASI in 2022 identified several key issues and guidelines that will need to be considered in a more detailed feasibility study of the mission. The recommendations and guidelines provided by the pre-feasibility study could be used as a starting point for the more detailed main feasibility study, which will be conducted over the next three years from 2023 to 2025. During this time, KASI and its collaborators will further investigate the technical and financial feasibility of the mission, refine the scientific objectives and requirements, and develop a detailed plan for executing the mission. In this talk, we will briefly introduce the main results from the pre-feasibility study, and discuss how to implement them in the main feasibility study to ensure the success of a Sun-Earth Lagrangian L4 mission led by Korea.

제3발표장 301호

II-3 우주기술/지상 및 인프라 운영기술

Chair: 임조령 (항우연)

16:25 [II-3-1]

Normal Stress Redistribution in Wheel-Soil Interaction of Lunar Rover due to Grouser Tip-Induced Soil Removal

Viet Dinh Le, Yujin Lim, Pierre Anthyme Bahati

Paichai University, Daejeon, South Korea

The wheel-soil interaction model, associated with empirical models, is crucial in the design of autonomous lunar rovers. The lugged wheel is frequently used in rover design and has been studied in theoretical and experimental models by many researchers. Effect of wheel grouser tips on shear displacement and shear stress has been considered and investigated in previous research. However, redistribution of normal stress on the wheel when the grouser tip removed the soil in the entry contact area in front of the wheel still leaves a gap in the terra-mechanics field. In particular, this contact area is significant because it determines the distribution of normal stress, the entry contact angle, and the starting point of the shear displacement. The wheel convex part and grouser tip are influencing factors to the entry contact area. Also, the effect of the grouser tip on this contact area depends more or less on the wheel convexity. In study we developed an improved wheel-soil interaction model based on the redistribution of the normal stress approach and several pressure-sinkage empirical models. Model validation works well compared to the well-known results investigated by Ding (2015). Several parameters required for the wheel-soil model are obtained by performing a single-wheel test. A reasonable comparison between simulated and experiment models can be obtained with consideration of slippage.

16:40 [II-3-2]

Active Space Debris Removal Mission: Mission Design and Trajectory Optimization for Protecting Orbital Service of Low Earth Orbit Satellites

Jin Haeng Choi, Chandeok Park

Yonsei University

This study presents the mission planning and trajectory design for the Active space Debris Removal (ADR) mission. In recent years, the number of space debris in Low Earth Orbit (LEO) has been rapidly increasing, which jeopardizes the sustainable use of space environment. This study aims to effectively protect operational satellites by actively removing space debris that pose collision threats to LEO satellites (e.g., KOMPSAT, STSAT). Target debris are carefully taken from the NORAD catalog and are prioritized according to the criticality criteria that consider the orbital lifetime, collision probability, and physical properties of debris. The trajectory design problem is formulated as an optimization problem that minimizes the total velocity increments used for the transfer to target debris. Lambert's problem and Hohmann-type transfer are used in computing velocity increments, and evolutionary algorithms are used to obtain optimal spacecraft trajectories satisfying the mission constraints. The proposed ADR mission planning and removal trajectory optimizations are demonstrated with representative examples. Accoriding to preliminary numerical experiments with simple dynamic models, our approach can remove seven pieces of debris with a velocity increment of less than 2.5 km/s. The RAAN drift effect turns out to substantially reduce total velocity increments. The overall simulation results indicate that a careful and systematic mission/trajectory design is critical in increasing the efficiency and reducing the cost.

16:55 [II-3-3]

System Monitoring Data for KMTNet 18k CCD Camera

Sang-Mok Cha, Chung-Uk Lee, Dong-Joo Lee, Dong-Jin Kim, Yongseok Lee, Seung-Lee Kim

Korea Astronomy and Space Science Institute

We record and utilize various data to monitor the status of the 18k CCD camera and the observation system in KMTNet. The data have been collected since the installation of KMTNet, and long-term health histories have been accumulated for each part of the CCD camera system. To check the consistency of CCD performance and characteristics, conversion gains and readout noise are measured weekly using dome flat data. The measurement and monitoring of linearity and other features are conducted. For system maintenance, we record the pressure and temperature inside the CCD Dewar, as well as the status of the CCD cooler operation. In addition, the status of the CCD controller, temperature/humidity inside the equipment room, and power monitoring logs for PDUs and UPSs are utilized. Since all KMTNet systems are operated overseas, there are various restrictions on maintenance activity. This presentation will introduce how KMTNet system monitoring data are utilized in practical maintenance.

17:10 [II-3-4]

Strategies for Asteroid Frozen Orbit Design Subject to Dynamics Incorporating Solar Radiation Pressure Models

Jinah Lee, Chandeok Park

Department of Astronomy, Yonsei University

This study presents (1) analyses on solar radiation pressure (SRP) models for asteroid probes and (2) the associated frozen orbit design under SRP and zonal effects. Asteroid exploration has been steadily developed for the purpose of discovering the secret of the Solar System and verifying space technology. Unique/Varied shapes and small sizes of asteroids underline the importance of analyzing their dynamical environments before exploration. Recognizing that SRP is a significant source of disturbance/perturbation affecting asteroid probe motions, we first introduce some representative SRP models and investigate which one suits for a long-term propagation near asteroids. Only *analytic* SRP models are considered, as empirical ones have been primarily developed for satellites on low/medium Earth orbit. Computing time or computational load shows insignificant variation across different SRP models. Based on these analysis, a frozen orbit is designed with a selected SRP model. Frozen orbit studies with SRP typically consider the cannon-ball model, which does not account for diffusing reflection. The underlying idea in this study is to approximate the selected SRP model to a cannon-ball model, and to convert the coordinate frame into one that best suits the approximation. The proposed idea is applied to designing the frozen orbit of 1036 Ganymede whose semimajor axis is 182.33 km at the initial epoch. Numerical experiments result in 65.03% reduction in the mean variation of eccentricity. Since the proposed frozen orbit has small variation of orbit elements, it is suitable for serving as the initial orbit for a long-term propagation of asteroid probes.

17:25 [II-3-5]

GK2A P-OBT Drift Set Automation Design

Junghyun Lee, Hyunkyu Shin, Sungsik Huh, Sangcherl Lee, Cheolhea Koo

Korea Aerospace Research and Institute

Accurate time recognition of satellites is required for the precise orbit and attitude determination, imaging accuracy, etc. In the case of GK2A, recognizing time in the satellite is called OBT (On Board Time), which is required synchronizing with Universal Time Coordinated (UTC) due to OBT time drift. The drift should be predicted in ground station and uplinked to the satellite. Previously, the predicted drift value is determined intuitively by engineers. Then GK2A calculate P-OBT with OBT and the received drift, which is considered UTC. In this study, an automation algorithm for the OBT drift set calculation was developed and applied to GK2A operation about 1 years, which generate reasonable results.

“This research was supported and performed by GEO-KOMPSAT-2A Meteorological Mission Operation program funded by National Meteorological Satellite Center (NMSC), Korea Meteorological Administration (KMA).”

4월 27일(목) 제1발표장 Convention I

특별강연

Chair: 이호규 (과학기술정책연구원)

09:00 [특별강연]

Introduction of 4th Space Development Promotion Basic Plan and Establishing Space Exploration Roadmap

제4차 우주개발진흥 기본계획 및 우주탐사 로드맵 수립 계획 소개

임종빈

과학기술정책연구원 국가우주정책연구센터

정부는 2022년 12월 2045년까지의 우주개발 추진 방향을 담은 제4차 우주개발진흥 기본계획(이하 4차 기본계획)을 발표하였다. 4차 기본계획은 기존 핵심 우주시스템 확보 중심에서 중장기 우주개발 임무 중심으로, 위성 및 발사체 기술개발 중심에서 우주탐사 · 과학까지 확장을, 공공주도 연구역량 · 인프라 확보에서 민간참여 우주산업 확대로 정책 방향을 설정하였다. 또한, 이러한 정책을 추진하기 위해서 5대 장기 임무를 설정하였는데, 그중 2가지가 '우주탐사 확대'와 '우주과학 확장'이다. 이에 정부는 2023년부터 2024년에 걸쳐 두 개의 장기 임무에 대한 '대한민국 우주탐사 50년 로드맵'을 도출할 계획이다. 본 발표에서는 이러한 정부 우주탐사 · 과학 발전을 위한 정책을 소개하고, 전문가들의 다양한 의견을 청취하고자 한다.

제1발표장 Convention I

III-1 태양 및 우주환경 III

Chair: 김정헌 (천문연)

09:40 [III-1-1]

Assessment of Ionospheric Ion Velocity Measurements from VIPIR/Dynasonde at Jang Bogo Station, Antarctica

Hyuck-Jin Kwon[1], Geonhwa Jee[1,2], Young-Bae Ham[1,2], Nickolay Zabotin[3], Changsup Lee[1,2], Eunsol Kim[1], Terrence Bullett[3]

[1]*Korea Polar Research Institute*
[2]*University of Science and Technology*
[3]*University of Colorado, Boulder, Colorado, USA*

Since 2017, Korea Polar Research Institute (KOPRI) has been operated an ionospheric radar system called Vertical Incidence Pulsed Ionospheric Radar (VIPIR) equipped with Dynasonde analysis at Jang Bogo Station (JBS). The two-dimensional plasma velocity is one of the ionospheric parameters obtained from the radar. We compared measurements of ionospheric plasma flow over JBS, made by VIPIR with simultaneous observations of the Doppler velocity obtained from SuperDARN HF radar at Dome C. When we compared plasma velocities on the horizontal plane, zonal velocity showed a positive relation, while meridional velocity revealed a very poor relation. The difference is due limitation of SuperDARN observations, because SuperDARN observed only line-of-sight (l-o-s) direction. In order to compare magnitude of flow velocities, we projected two-dimensional horizontal plasma velocity by VIPIR onto the one-dimensional l-o-s direction of SuperDARN. The result represents reasonable agreement both two measurements, with correlation coefficient close to 0.6. We found also, the correlation coefficient increased as the geomagnetic condition enhanced from quiet to disturbed. Based on these results, we suggest that the movements of small-scale plasmoids follows the large-scale ionospheric motions and this tendency is enhanced with the level of geomagnetic disturbance.

09:55 [III-1-2]

Effect of Radiative Relaxation on Intensity-Velocity Phase Difference in Umbral Oscillations

Kyeore Lee, Jongchul Chae

Seoul National University

We study how radiative relaxation affects the phase difference between intensity and velocity variations in chromospheric umbral oscillations. We use a simple analytic solution with a fixed cutoff frequency to estimate the relaxation time from the observed phase difference. We measure the intensity and velocity variations from the spectral data of the Ha and NaI lines obtained with the FISS. We find that shorter relaxation time leads to larger phase difference for all frequencies. The Ha line shows shorter relaxation time than the NaI line, indicating stronger radiative relaxation in sunspot umbrae. Large phase differences beyond −90 degrees can appear as downward wave propagation. Our results suggest that apparent downward propagation is more common in Ha than in NaI due to radiative relaxation. Further works with realistic cutoff frequency are needed to understand our finding better.

10:10 [III-1-3]

Dynasonde Observations of Ionospheric Polar Holes under Quiet Geomagnetic Conditions at Jang Bogo Station, Antarctica

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

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

Noticeable F-region electron density (NmF2) depletions were observed in the winter/nighttime polar cap ionosphere during solar minimum from the Vertical Incidence Pulsed Ionospheric Radar (VIPIR) with Dynasonde analysis at Jang Bogo Station (JBS) in Antarctica. We focus on the F-region depletion events (known as polar holes) following a steady quiet condition that is defined with Kp values ≤ 1+ during 6 h. 45 polar holes were identified by JBS VIPIR/Dynasonde (JVD) in 2019. All of the events started over a wide range of nightside magnetic local time (22–05 MLT) with a peak occurrence at 01–03 MLT. JVD measured exponential NmF2 decrease in the nightside MLT (~19–2.5 hr) zone with e-fold decay time distributed in the range of 0.5–4 hours before the onset of a polar hole. The e-folding times decrease along the longitude from dusk toward

midnight. The horizontal ion drift velocity (V_{hor}) estimated from JVD monotinically goes down from ~190 m/s at 18 MLT to ~100 m/s near magnetic midnight, and the NmF2 is depleted as V_{hor} decreases prior to the polar hole formation. This positive correlation between NmF2 and V_{hor} implies that the electron density depletion is due to slow antisunward plasma convection in darkness and in the absence of an ionization source. That is, the plasma density depletion in the polar F2 layer is directly related to plasma residence time in the nighttime MLT zone in the absence of ionizationsources and under quiet geomagnetic conditions.

10:25 [III-1-4]

A Statistical Analysis of Wave Characteristics between Storm and Non-Storm Periods of Mid-Latitude Pc1 Waves during the 24th Solar Cycle

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Jaehueng Park[1,2], Jiwoo Kim[3], Hyangpyo Kim[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy and Space Science, University of Science and Technology*
[3]*Department of Astronomy, Space Science and Geology, Chungnam National University*
[4]*Space Research Institute (IWF), Graz, Austria*

Pc1 pulsations (or waves), which can be detected at mid-latitude ground stations, are known to originate from electromagnetic ion cyclotron (EMIC) waves generated at the ring current region. Many studies have been carried out to discover how the waves change their properties during propagation. However, few studies have directly compared the characteristics of Pc1 pulsations during storm and non-storm periods using long-term ground-based data. In this study, we compared storm-related and non-storm-related Pc1 pulsations detected at a mid-latitude ground station (BOH; L~1.34). We found that Pc1 pulsations that occurred during non-storm period have a sharper peak in the local time distribution of the occurrence rate. Additionally, storm-related Pc1 pulsations tend to have higher frequencies and more left-handed polarizations (LHP) when the related storm is more intense. Also, Pc1 pulsations detected during non-storm period tend to have frequencies concentrated around 0.6–1 Hz. The frequency of the two groups seems to be clearly separated. These results suggest that storm-related Pc1 pulsations may have a more diverse range of spatial sources.

10:40 [III-1-5]

Investigation Plan of the Degree of Linear Polarization of the Solar F-Corona on the CODEX and the Total Solar Eclipse

Heesu Yang, Su-Chan Bong

Korea Astronomy and Space Science Institute

The degree of linear polarization (D_F) of the solar F-corona is one of the most poorly understood pieces of the Sun. In this presentation, we show the possibility of measuring D_F using filter observations from the Coronal Diagnostic Experiment (CODEX), as well as the imaging-spectropolarimetric observations during the total solar eclipse (TSE) of 2024. Connecting the result of the CODEX and the TSE 2024, we can unveil the full radial distribution of D_F, which has not been investigated yet. If our observations are successful, we will be able to update current radial distribution model of the D_F, which was developed based on many assumptions. Moreover, the results will provide crucial information on the shape, composition, and distribution of the F-corona.

10:55 [III-1-6]

Chromospheric Umbral Oscillations Driven by the Subphotospheric Resonance of Fast Magnetohydrodynamic Waves

Juhyung Kang[1], Jongchul Chae[1], Kyuhyoun Cho[2,3], Soosang Kang[1], Eun-Kyung Lim[4]

[1]*Seoul National University*
[2]*Bay Area Environmental Research Institute*
[3]*Lockhead Martin Solar and Astrophysics Laboratory*
[4]*Korea Astronomy and Space Science Institute*

Intensity and velocity oscillations are the most prominent chromospheric dynamical phenomena in sunspot umbrae. Recent observational studies have paid to their horizontal patterns across the magnetic field, but their physical nature and origin are still elusive. Here we show that the chromospheric umbral oscillation patterns of slow waves are driven by the superposition of the several resonant modes of fast body waves in the subphotosphere. Our model successfully reproduces the observed patterns. According to our model, only a few low-order modes can be trapped in the umbra by the effect of the cutoff wavenumber, and this effect is identified in the observation. The subphotospheric fast resonant waves inherit their patterns to the chromospheric slow waves through the fast-to-slow mode conversion process. Our research sheds light on the subphotospheric seismology in the sunspots in that we can infer the unobservable atmospheric condition from the observed chromospheric oscillation patterns.

11:10 [III-1-7]

Proposal of a New Method for Estimating Mesospheric Gravity Wave Activity Using Specular Meteor Radar

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

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

The specular meteor radar (36.2°N, 124.1°E) operated by KASI observes the exponential decay of under-dense meteor trails entering the Earth's atmosphere at altitudes of 80-100 km. The diffusion coefficient can be estimated from the decay time, and the diffusion of meteor trails is strongly influenced by the pressure and temperature of the ambient background atmosphere, following ambipolar diffusion. Additionally, we propose using temperature perturbations as a proxy for atmospheric gravity waves to assess the activity of gravity waves in the mesosphere and lower thermosphere (MLT) region over the Korean Peninsula based on perturbations in the diffusion coefficient. In this study, we will propose a new method to infer the activity of gravity waves. We derive the perturbation of the diffusion coefficient by subtracting the background, and then we can easily examine the activity of gravity waves in the altitude range of 85-95 km as a single layer, according to season and local time. This will help to increase our understanding of atmospheric waves in the MLT region of Korea.

11:25 [III-1-8]

Verification of the KIDARiM Model's Prediction Results on the Ionosphere over the Korean Peninsula

Jeong-Heon Kim[1], Young-Sil Kwak[1,2], Se-Heon Jeong[1], Daekyu Shin[3], Jongyeon Yun[4], YongHa Kim[5]

[1]*Korea Astronomy and Space Science Institute, KASI*
[2]*University of Science and Technology, UST*
[3]*Space Environment Laboratory, SELab*
[4]*Korea Space Weather Center, KSWC*
[5]*Chungnam National University, CNU*

The ionospheric environment over the Korean Peninsula, which is located at mid-latitudes, is influenced by various energy sources. Also, it is a region where ionospheric storms exhibit a bidirectional pattern (positive or negative storm) when geomagnetic storms occur. To predict the mid-latitude ionospheric characteristics of the region accurately, the Korea Ionospheric Data-Assimilation Region Model (KIDARiM) was developed using data assimilation techniques. This model is divided into three parts: data assimilation (IDA4D) part, extracting ionospheric drivers (TIE-GCM), and ionospheric prediction part using the Korea Ionospheric Prediction Model (KIPM) model (Kim et al. 2022) with a 1 deg. (latitude) ×1 deg. (longitude) ×10 km (altitude) resolution. In the final prediction stage, the KIPM utilized the optimal initial condition generated from the data assimilation part as the model's initial field. As the prediction progresses, the thermal wind information derived from the TIEGCM model is nudged every 15 minutes. In this study, we present the performance evaluation and validation of the KIDARiM model. We compared and analyzed VTEC observation data from the Daejeon region of South Korea and ionospheric data (NmF2, hmF2) from Okinawa and Kokubunji, Japan, and evaluated the performance of the KIDARiM and IRI-2016 models. The KIDARiM model outperformed the IRI-2016 model by approximately 52% in terms of daily average VTEC root mean square error during quiet space weather conditions (July-September 2020) in the Daejeon region, and also showed superior performance in the Japanese region. During a geomagnetic storm period in February 2014, the KIDARiM model performed about twice as well as the IRI-2016 model and successfully predicted the storm. We plan to improve the reliability of the model through longer-term validation and address the identified limitations in future studies based on these results.

11:40 [III-1-9]

Alfvén Wave Transport in the Solar Chromosphere and Corona: A Simple Layer Solution

Jongchul Chae, Kyoung-Sun Lee

Seoul National University

Alfvén waves are believed to be closely relevant to the three outstanding problems in the solar corona: coronal heating, solar wind acceleration, and the fractionization of low FIP elements. We present an analytical solution for Alfvén wave in a simple layer where Alfvén speed varies with a constant gradient whereas density may vary arbitrarily. The transmission of Alfvén waves through this layer is characterized by two parameters: the cutoff frequency determined by the gradient of Alfvén speed and the thickness of the layer determined by the ratio of Alfvén speed between the two boundaries. Our results indicate that the pondermotive acceleration originating from Alfvén waves is always directed upwards in the solar atmosphere and becomes the strongest in the chromosphere-corona transition region, especially when low frequency waves propagate downwards. We also find that in the chromosphere, Alfvén waves are better transmitted to the corona along highly inclined field lines than along vertical field lines.

제2발표장 Convention II

III-2 우주감시

Chair: 최 진 (천문연)

09:40 [III-2-1]

OWL-Net Observations of Near-Earth Asteroid 2023 BU: Physical Properties and Implications for Planetary Defense

Hee-Jae Lee, Myung-Jin Kim, Hong-Suh Yim, Dong-Goo Roh, Jin Choi, Jang-Hyun Park, Young-Sik Park, Jung Hyun Jo, Jaemann Kyeong, Jiwoong Yu, Hong-Kyu Moon, Yoon-Ho Park, Sungki Cho, Eun-Jung Choi

Korea Astronomy and Space Science Institute

Near-Earth asteroids pose a potential threat to our planet, with many small objects passing in close proximity to Earth. While some asteroids have well-known and precisely measured orbits, many are discovered only days before their closest approach, requiring rapid determination of their orbit and physical characteristics to assess their impact hazard.

The small near-Earth asteroid 2023 BU has a diameter of 3-8 meters and was discovered by Gennady Borisov at the Crimean Peninsula's MARGO Observatory on January 21, 2023, and passed by approximately 36,000 km above the Earth's surface on January 27, 2023. Although the asteroid did not pose a collision threat, it provided an opportunity to practice our response to near-Earth asteroid threats.

In this talk, we report the observational result of 2023 BU obtained using OWL-Net (Optical Wide-field patroL Network). Our observations covered one day before and one day after the close approach to Earth. Based on these data, we determined the basic physical properties of 2023 BU, including its rotation period, axial ratio, and size. Additionally, we discuss the improvement of the orbit precision as observations accumulated.

09:55 [III-2-2]

Korea Meteor Monitoring and Observation Network (K-M^{2}ONet): Status Update and Modified Data Reduction Process

Yun Hak Kim[1], Dong-Goo Roh[1], Jang-Hyun Park[1], Sungki Cho[1], Jung Hyun Jo[1], Jeong Yoo Hong[1], Hong-Suh Yim[1], Mansoo Choi[1], Myung-Jin Kim[1], Eun-Jung Choi[1], Jin Choi[1], Jiwoong Yu[1], Hee-Jae Lee[1], Jaemann Kyeong[1], Ki pyoung Sung[1], Sung-Yeol Yu[1], Seokmin Song[1,2], SeongHo Son[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*Chungnam National University*
[3]*Open Sky Partners Inc.*

Korea Meteor Monitoring and Observation Network (K-M^{2}ONet) has now been established at 16 sites with a static survaillance strategy. The main role of this system is to detect bright enough falling meteors on the south Korean peninsula and furthermore, the system also acquire their trjajectorial properties to estimate the potential crash areas.

K-M^{2}ONet has now been in a phase of test operation. Hence, we introduce partially modified and upgraded meteor detection algorithm and demonstrate the updated status of the system.

10:10 [III-2-3]

Autonomous Geometric Calibration of All-Sky Camera Using Graph Matching Method

Jang-Hyun Park

Korea Astronomy and Space Science Institute

An algorithm for autonomous geometric calibration of all-sky camera using graph matching method will be presented. All-sky cameras are used for various purposes to assist astronomical observation, but their application is limited because of severe distortion and difficulty in accurate photometry. To increase the usability of the all-sky camera, geometric calibration is required. Due to their wide field of view and severe distortion, their calibration processes are much different from the general astronomical image calibration. The first process for their calibration is to identify multiple stars whose astronomical coordinates can be extracted from star catalogues. An automatic calibration process is necessary to calibrate a bunch of all-sky cameras periodically. We have adopted Graph Matching method to automate this process. We are going to present some initial results and to discuss its application.

10:25 [III-2-4]

Real-Time Spatiotemporal Reasoning for Safe and Efficient Space Using AstroLibrary

Shawn SH Choi[1,2,3], Peter JH Ryu[1,2], Chanyoung Song[2,3], Hyunwoo Kim[2,3], Junhee Jang[2,3], Minwoo Ji[2,3], John Kim[1], Lowell Kim[1], Douglas DS Kim[1,2,3]

[1]*SPACEMAP Inc.*
[2]*Voronoi Diagram Research Center, Hanyang University*
[3]*School of Mechanical Engineering, Hanyang University*

The increasing number of satellites in geospace and their applications in our daily lives require the safer, more efficient, and sustainable use of geospace. Developing more accurate and efficient software that covers all aspects of space-related activities in a rapidly changed space environment is crucial. The

catalogue size will increase rapidly due to improved sensors, more launches and satellite deploys, Kessler syndrome, etc. Query diversity requires to cover not only safety issues but also the optimal operations of constellations of hundreds of and sometimes thousands of satellites. To make things harder, many problems require real-time responses. These changes together demands the introduction of a better algorithm and more effective framework for software developers in the global perspective. Here we introduce AstroLibrary to respond to this global demand. It consists of RESTful APIs that can be conveniently used by software developers for easily and quickly developing computer programs related to the spatiotemporal reasoning about many spacecrafts. AstroLibrary is designed to respond to queries in real-time or near real-time with the best possible solutions. Currently, RESTful APIs in AstroLibrary can be used via the http protocol. Two example APIs. (1) Do the conjunction assessment of the entire LEO objects in the TLE database during next 48 hours. (2) Do the conjunction assessment (and many other spatiotemporal analyses) of new spacecraft insertions against the entire TLE objects using the ephemeris data. AstroLibrary is based on the dynamic Voronoi diagrams of moving space objects and is the basis of the SPACEMAP platform running on AWS (spacemap42.com). AstroLibrary will enable space operators to make more informed decisions and improve the safety and efficiency of space operations.

10:55 [III-2-5]

Real-Time Conjunction Assessment with Collision Probability and Miss Distance Using AstroFingertip of SPACEMAP

Peter JH Ryu[1,2], Shawn SH Choi[1,2,3], Chanyoung Song[2,3], Hyunwoo Kim[2,3], Junhee Jang[2,3], Minwoo Ji[2,3], John Kim[1], Lowell Kim[1], Douglas DS Kim[1,2,3*]

[1]*SPACEMAP Inc.*
[2]*Voronoi Diagram Research Center, Hanyang University*
[3]*School of Mechanical Engineering, Hanyang University*

The increasing number of resident space objects (RSOs) in geospace due to more launches and satellite deploys leads to a higher collision probability between RSOs. With RSOs traveling at the speed of several times of bullet, e.g. 7 to 8 km/s, the consequence of the collision can be catastrophic. Furthermore, the cost of maneuvering satellites is becoming more expensive. Therefore, an accurate and efficient prediction of conjunctions is becoming increasingly crucial. However, even with a moderate-sized space catalogue, predicting conjunctions efficiently and accurately remains a challenge, and it will remain so as the catalogue grows rapidly due to many launches and enhancement of measurement technology. Here we present the AstroFingertip of SPACEMAP which can do conjunction assessment based on both miss distance and collision probability in (near) real-time. AstroFingertip reports the conjunction assessment of user's space asset with the miss distance and collision probability at time of closest approach in real-time. SPACEMAP's collision avoidance function produces the optimal maneuver plan of a predicted conjunction from a set of either user-supplied or SPACEMAP-generated alternatives in near real-time. SPACEMAP utilizes a new geometric construct called Voronoi diagrams to efficiently predict conjunctions of many alternatives. Currently, SPACEMAP uses the TLE data from Space-track, but incorporating other data types such as commercial SSA data, telemetry data (e.g. GPS), measurement data (e.g. radar), etc. is straightforward. By enabling real-time or near real-time assessment of conjunctions and providing optimal maneuver plans, SPACEMAP helps improve the safety and efficiency of space operations.

11:10 [III-2-6]

Prototype Production for Space Debris Surveillance Radar Technology Development

Jong-Ki Shin[1], Kyung-An Jung[1], Sung-Jae Lee[1], Andrew Chung[1], Sungki Cho[2], Jiwoong Yu[2]

[1]*Kipco Radar & Aerospace*
[2]*Korea Astronomy and Space Science Institute*

As the possibility of space risks such as falling space objects and collisions between space debris and space assets increases due to continuous space development, in accordance with the 「1st Space Risk Countermeasures」 established, 'space object monitoring and observation infrastructure' is part of the technology development project. We are developing the radar since December of 2020. The goal of the project is to build a test bed for a space debris monitoring radar system for monitoring man-made space objects in low Earth orbit. For this purpose, design for radar system production and operation has been carried out, and some of the radar system components are being manufactured and tested as prototypes. In this paper, we will briefly present the current status in development of the radar system and the plan.

11:25 [III-2-7]

Space Object Measurement and Identification Test Results Using Radar Assets of the Republic of Korea Air Force

Jiwoong Yu[1], Sungki Cho[1], Sujin Lee[2]

[1]*Korea Astronomy and Space Science Institute*
[2]*Republic of Korea Air Force*

The Space Surveillance Radar is a space surveillance facility that

can be observed in all weathers and day and night. The Korea Astronomy and Space research Institute (KASI) is developing a space surveillance radar test bed and plans to test it in the second half of 2024. There is no space surveillance radar that can be operated in Korea yet, and leads to a security vacuum occurs in space surveillance. In order to fill the security vacuum, test observations were conducted using the Air Force's radar assets and applying them to space surveillance. Two radar assets were observed over several days, and most of the identification was successful when the observation results were identified based on Two Line Elements (TLE). Air Force radar assets were confirmed to be useful as a space surveillance facility. It is expected that these radar facilities will be used for space situational awareness in times of national crisis or need.

11:40 [III-2-8]

Review of the Monitoring and Observation of the Final Re-Entry Trajectory of ERBS Satellite

Eun-Jung Choi, Jin Choi, Dong-Goo Roh, Yun-Hak Kim, Sungki Cho

Korea Astronomy and Space Science Institute

This paper presents the points to be reviewed for the space risk response system through the monitoring and observation of the final re-entry trajectory of NASA's retired Earth Radiation Budget Satellite (ERBS). The ERBS, launched in 1984 and shut down in 2005, reentered Jan 9. And, in fact, on January 9, a satellite reentry situation was observed on the Korean Peninsula. NSSAO estimated a reentry at 12:49 p.m. KST, plus or minus 30 minutes, based on the analysis from KASIOPEIA (KASI's Orbit Propagation & estimation, integrated analysis system), an Space Situational Awareness (SSA) total solution. Due to the risk associated with the passage of the space object ERBS through the Korean peninsula, an emergency meeting was held, headed by Ministry of Science, ICT and flights have been totally restricted during the reentry prediction window.
Based on this reentry predication and actual observations, we analyzed lesson learned for national space risk response system.

제3발표장 301호

III-3 SS: Space Laser Communication

Chair: 임형철 (천문연)

09:40 [III-3-1]

Analysis of Laser Communication Link Budget between Low Earth Orbit Satellites and Ground

Jin Pyong Jung

Korea Aerospace Research Institute

Laser communication is gaining attention as the next-generation space communication technology due to its advantages of wide bandwidth, transmission information security, and Low SWaP (Size, Weight and Power) characteristics. In particular, low earth orbit (LEO) satellites have high utilization due to their short transmission distance, low latency, and low-cost launch capabilities, and the emergence of high-resolution remote sensing sensors for satellite use and the concept of next-generation mobile communication networks using satellite communication networks has made the broadband link between LEO satellites and the ground essential. In this paper, based on the system requirements of LEO satellites operated and planned in Korea, I analyzed the link budget considering factors such as satellite altitude, transmission power, beam width, and optical antenna size.

09:55 [III-3-2]

Performance Analysis of PPM Signals Having Finite Extinction Ratios in Free-Space Optical Communication

Jihoon Lee, Hoon Kim

Korea Advanced Institute of Science and Technology

Pulse-position modulation (PPM) has long gained popularity in deep-space optical communications due to its inherent energy efficiency. Since PPM is a orthogonal modulation format, it requires a very low optical energy per bit with an increasing modulation level. However, to achieve maximum performance, optical PPM signals must have high extinction ratios (ERs), which is very challenging to realize in practice. In this work, we analyze the receiver sensitivity degradation of PPM signals caused by finite ERs. We use Monte-Carlo simulations to study the impact of finite ER on receiver performance for different modulation levels, when using a photo-sensitive avalanche-photodiode for the detector.

10:10 [III-3-3]

Preliminary Results of Space Optical Communication Experiments

Wonseok Kang[1], Taewoo Kim[1], Sang Hoon Oh[1], Yong-Sun Park[1,2], Jung-Hoon Kim[1,3], Jinil Kang[4], Hyunjoong Son[4]

[1]*Spacebeam, Inc.*
[2]*Seoul National University*
[3]*SETsystem, Inc.*
[4]*BORsys Corp.*

Satellite tracking and optical systems are essential techniques

for space-based optical communication at the Optical Ground Station (OGS). In this work, we present preliminary results of precise tracking of LEO satellites and ground-based free-space optical communication (FSOC) experiments using commercially available catalog parts. Open-loop control is used for tracking since the orbits computed by the Simplified General Perturbations model 4 (SGP4) using publicly available Two-Line Elements (TLE) sets are not precise enough. The achieved tracking precision is better than 10 arcseconds with an RMS error of less than 5 arcseconds. We carried out two types of FSOC experiments at a distance of approximately 500 m. The first experiment was performed by using a laser diode and APD, while the second experiment used SFPs and media converters. These experiments were very successful, validating the feasibility of FSOC with a small telescope. In the near future, we plan to increase the communication distance to over 2 km.

10:25 [III-3-4]

Development of Small Size Space Laser Communication Terminal Prototype

Kiwook Baeck, Paulo Kemper, Hyosang Yoon

Korea Advanced Institute of Science and Technology

Spacecraft Prototyping Laboratory in KAIST is currently working on developing a laser communication terminal designed for nanosatellites. One of the key features of the system is the precise pointing required for space laser communications. We has designed and tested a laser pointing control system as a development model prior to making the terminal. The terminal occupies a volume of 1.2 U, making it appropriate for CubeSats 3 U or larger. The mechanical and electronic components of the communication terminal have already been developed and tested, leaving only the integration test as future work. We briefly provides the current development status and the plan for the next.

10:40 [III-3-5]

Miniaturization of Optical Wireless Communication System for Space Laser Communication

Chan Il Yeo[1], Young Soon Heo[1], Siwoong Park[1,2], Keo Sik Kim[1], Hyung Jun Park[1]

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

For ground-satellite and satellite-satellite space laser communication, miniaturization and weight reduction of space optical communication terminals are significantly important. This is because they are directly related to reducing launch costs and expanding room for other science instruments. In this paper, based on the research results of our mobile optical wireless communication system designed to provide a gigabit full-duplex wireless optical data link between a ground system and an unmanned aerial vehicle, various design factors to be considered for miniaturization and weight reduction of the space optical communication terminals will be discussed. In addition, space optical communication terminals developed by several space agencies will be reviewed to draw additional improvements.
This work was supported by Electronics and Telecommunications Research Institute (ETRI) grant funded by the Korean government. [23ZK1100, Honam region regional industry-based ICT convergence technology advancement support project].

10:55 [III-3-6]

Development and Introduction of SLODAR Equipment

Seok Gi Han[1], Seok Young Ju[1], Ji Yong Joo[1], Hyeon Seung Ha[1], Jun Ho Lee[1], Jeon Geon Kang[2], Eui Seung Son[2], Howoo Chiang[3], Ji-young Jung[3]

[1]*Department of Optical Engineering, Kongju National University*
[2]*Defense Industry Technology Center*
[3]*Hanwha Systems*

In the case of the space-to-ground laser communication optical system, information communication data loss occurs due to atmospheric disturbance generated by the atmosphere. There are various attempts to check this atmospheric disturbance information, but we have acquired atmospheric information through SLODAR equipment, developed SLODAR equipment, and would like to introduce it. SLODAR equipment uses binaries and physically separates the path of light using prisms, and acquires data through a wavefront sensor for each separated light, and when data processing is performed, atmospheric information can be obtained at 8 intervals at 0.5-9 km altitudes. The advantage of SLODAR operation is that the rest of the data can be obtained except for the ground part, which is the largest part of atmospheric disturbance. As we proceed with the development of these SLODAR equipment, we will introduce the elements of development progress and introduce the technology development contents that have been carried out so far.

11:10 [III-3-7]

Implementation and Comparison of LTAO Algorithm Using Learn & Apply Method

Seok Young Ju[1], Seok Gi Han[1], Ji Yong Joo[1], Hyeon Seung Ha[1], Jun Ho Lee[1], Jeon Geon Kang[2], Eui Seung Son[2], Howoo Chiang[3], Ji-young Jung[3]

[1]*Department of Optical Engineering, Kongju National University*
[2]*Defense Industry Technology Center*

[3]*Hanwha Systems*

Adaptive optics (AO) refers to a technology that improves the performance of the optical system by correcting distorted wavefront. When stars are observed on the ground, atmospheric turbulence occurs in the process of plane waves from celestial bodies entering the Earth's atmosphere and reaching the ground. Adaptive optics compensates for atmospheric disturbance in real time in the form of a plane wave, and can achieve the same effect as observing a celestial body outside the atmosphere. Adaptive optical methods have been diversified to achieve better performance while compensating for the shortcomings of the adaptive optical system. Adaptive optical operational techniques are divided into SCAO (Single Conjugate AO), LTAO (Laser Tomography AO), MOAO(Multi Object AO), and MCAO (Multi Conjugate AO). (1) LTAO, discussed in this paper, is a method that increases the available celestial sphere by creating several artificial stars (LGS) using one natural star (NGS) and Rayleigh scattering. At this time, by using the wavefront reconstruction method of the atmospheric fault, the celestial sphere is increased and the Strehl value is improved at the same time to improve the performance of the optical system. In this paper, among the wavefront reconstruction methods used in LTAO, the Learn & Apply algorithm was implemented using MATLAB software and compared with other wavefront reconstruction methods, the Modal method.

11:25 [III-3-8]

Ultra-Precision Manufacturing Technology for Freeform Surface Reflective Optics with Optical Communication Applications

Geon Hee Kim[1,2], Min Soo Yang[1], Young Duk Park[2], Jong Gyun Kang[3], Joong Kyu Ham[4], Young Tae Kwak[4], Seong Hyeon Park[4], Jin Yong Heo[2]

[1]*Department of Defense and Space Engineering, Hanbat University*
[2]*Department of Mechanics-Materials Convergence System Engineering, Hanbat University*
[3]*Department of Mechanical Engineering, Chungnam University*
[4]*Department of Mechanical Engineering, Hanbat University*

The demand for precision optical systems is rapidly increasing not only in aerospace but also in various fields such as military, automotive, and medical industries, leading to a growing interest in optical system design and manufacturing technologies. Among them, 3-mirror type optical systems with low optical distortion, high resolution, and a variety of focal lengths are used as infrared optical payloads for microscopes, satellites, unmanned vehicles, etc. Recently, research on laser communication in space and ocean environments is underway, and it is expected that this technology will be applicable to optical communication in the future.
However, to manufacture such customized optical communication systems, not only ultra-precision manufacturing technology for freeform reflective optics but also optical structural design/analysis and assembly/alignment evaluation technology for accurate light transmission are required. In this paper, we introduce the key technologies for manufacturing freeform reflective optical systems and developing ultra-precision optical system design/production technology applicable to optical communication.

11:40 [III-3-9]

Introduction to Convergence Cluster for Technology Development of Space Laser Communication

Hyung-Chul Lim, Mansoo Choi, Sung-Yeol Yu, Ki-Pyung Sung, Jonguk Park, Seonghwan Choi, Jeong-Yeol Han, Ryun-Young Kwon

Korea Astronomy and Space Science Institute

Space laser communication has gained significant attention as a promising alternative to radio frequency communication due to its potential advantages including high date rate, low power consumption and license free spectrum. So many space missions have been pushed to demonstrate and characterize the technologies of space laser communication since the first experiment of GEO-to-ground link in 1995. Recently, the Terabyte Infrared Delivery (TBIRD) program demonstrated a laser communication downlink at 200 Gbps between a 6U CubeSat and a ground station. So the project is being executed to analyze the technical status and levels, and then to establish the feasibility plan of space laser communication in Korea, which is supported by the National Research Council of Science and Technology, called the convergence cluster for technology development of space laser communication. The project is introduced in the study, including activities and future plan.

제4발표장 302호

III-4 안보 우주 II

Chair: 송세찬 (육군)

09:40 [III-4-1]

The Role of Space in Deterrence

Yungjin Jung

Korea National Defense University

Whether or not weapons are not deployed in space, the era in

which satellites could operate without potential threat is over. The question therefore arises: what actions can be taken and what trends encouraged to reduce the possibility of space becoming a theater, or a catalyst, for hostilities? The answer may lie not in the actions of nation states, but in the nature of the space environment on the one hand and the leadership of commercial space operators on the other.

09:55 [III-4-2]

Preliminary Design of GeoKompsat-3 Communications Payload System

Byoung-Sun Lee[1,2], Dongpil Chang[1], Cheon Sig Sin[1]

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

The GeoKompsat-3 (GK-3, Cheollian 3) program is a national R&D project to develop a geostationary communications satellite and ground systems from Apr. 2021 to Dec. 2027, funded by the Ministry of Science and ICT (MSIT), the Ministry of Environment (MOE), the Ministry of Land, Infrastructure and Transport (MOLIT), and the Korea Coast Guard (KCG). The Korea Aerospace Research Institute (KARI), as a general supervisory development organization, develops the overall system, spacecraft bus, and satellite ground control center. The Electronics and Telecommunications Research Institute (ETRI), as a payloads development organization, develps three types of communications payloads and ground verification system. The missions of the three types of communications payloads are as follows. The Ka-band Flexible Broadband Communications System (FBCS) will be used for maritime satellite communications, water disaster video surveillance, and the future mobile communications technology research. The L-band Data Collection System (DCS) will be used for securing stable water disaster monitoring information. The C-band uplink and L-band downlink Satellite Based Augementation System (SBAS) supports GPS satellite navigation data augmentation signal relay.

A preliminary design review meeting for the GK-3 satellite communications payload was held in January 2023, and a preliminary design review meeting for overall system is scheduled to be held around June. This paper describes the preliminary design of three types of GK-3 satellite communication payloads performed by ETRI.

10:10 [III-4-3]

Towards Space Security with SSA and STM Activities of Korea Aerospace Research Institute

Youeyun Jung, Jaedong Seong, Saehan Song, Okchul Jung, Daewon Chung

Korea Aerospace Research Institute

Since the activities in space has been increased and diversified such as Mega-constellation, space mining, and space travel, the importance of Space Situational Awareness (SSA) and Space Traffic Management (STM) has been tremendously rising globally. Space security can be obtained by not only advanced SSA and STM technology, but also relative legislation, and governance as well as international cooperation and recognization. Korea Aerospace Research Institute (KARI) has been developing and operating national space assets, and acting an important role for SSA and STM in Korea. This paper shows all activities on SSA and STM of KARI and propose a direction toward acquiring space security.

10:25 [III-4-4]

Optical Technology for Secure Space Security of Among Civilian-Government-Military

Geon Hee Kim[1,2], Min Soo Yang[1], Young Duk Park[2], Jong Gyun Kang[3], Joong Kyu Ham[4], Young Tae Kwak[4], Seong Hyeon Park[4], Jin Yong Heo[2]

[1]*Department of Defense and Space Engineering, Hanbat University*
[2]*Department of Mechanics-Materials Convergence System Engineering, Hanbat University*
[3]*Department of Mechanical Engineering, Chungnam University*
[4]*Department of Mechanical Engineering, Hanbat University*

As interest in space-based military power increases, investment and technological research are expanding to establish a civilian-government-military space ecosystem and space security system. To secure a space surveillance system, each country is securing its own space infrastructure, and cooperation among countries is strengthening for a comprehensive space monitoring and reconnaissance system that can detect, track, identify, and recognize the location and trajectory of moving objects of military interest. The focus is on developing a future military surveillance and reconnaissance satellite system that can quickly launch multiple satellites in case of an emergency and complement existing high-resolution surveillance satellite systems. However, to perform this mission, it is essential to deploy multiple small satellites at a low altitude and mount small/lightweight, high-precision optical systems to precisely detect and track unknown targets in a wide area on the ground. In this study, we aim to secure key technologies applicable to small satellite optical systems and apply them to EO/IR small satellites that can perform formation flight to enable wide-area observation.

10:55 [III-4-5]

Global Navigation Service System (GNSS) Signal

Interference on Araon Icebreaker

Jong-Kyun Chung, Junseok Hong

Korea Astronomy and Space Science Institute

GNSS (Global Navigation Satellite System) signals can be subject to various types of interference. Solar flare and geomagnetic storms can create ionospheric disturbances that affect the propagation of GNSS signals. Intentional interference with GNSS signals, often used for military purpose can distrupt or even disable GNSS signals.
GNSS signals interference by Iridum is a known issue that can occur due to the proximity of Iridium satellites to GPS or other GNSS satellites. Iridium is a satellite communication system that operates at a frequency band adjacent to that of GPS, GLONASS, Galileo, and other GNSS systems. When an Iridium transmitter is located near a GPS or GNSS receivers, it can cause interference and disrupt the GNSS signals. This can lead to degraded or lost positioning, navigation, and timing (PNT) information.
We will report and discuss an example of GNSS signals interference following an Araon Icebreaker's trajectory in the Arctic, Antarctic, and Pacific Ocean.

11:10 [III-4-6]

Orbit Determination of GPS Satellites: Orbit Correction Improvement via TEQC-based Stochastic Modeling of Multipath

Gyumin Kim, Jinah Lee, Jin Haeng Choi, Chandeok Park

Department of Astronomy, Yonsei University

This study presents the application of the Translate Edit Quality Check (TEQC) to the orbit determination (OD) of global positioning system (GPS) satellites. TEQC, a quality test program of the global navigation satellite system (GNSS) observation data, is used to generate *weights* at every designated epoch for 24 hours on February 1, 2020 for the GPS observation data obtained from 34 '*domestic*' reference stations only. These weights are incorporated into the measurement error covariance matrix of extended Kalman filter. It is first quantitatively analyzed how the stochastic modeling of multipath based on TEQC varies the performance of State Space Representation (SSR) orbit correction of GPS broadcast ephemeris. Our proposed stochastic modeling of multipath based on TEQC results in reducing such statistics as root-mean-square, standard deviation, and 95th percentile of the prefit residual. These analyses on the stochastic modeling by TEQC is further applied to improve the signal in space ranging error (SISRE) of GPS broadcast ephemeris relative to International GNSS Service (IGS) final product. Relative to the SISRE of the GPS broadcast ephemeris, our proposed correction improves SISRE by 0.33%, while the conventional correction improves by 0.12%. Though it constrains the overall performance to use domestic reference stations only, the overall process can still be used for SSR orbit correction with higher precision.

11:25 [III-4-7]

Ionospheric Perturbations by VLF Transmitters for Submarine Communications

Ho-Sung Choi[1], Jaeheung Park[2], Magnus F. Ivarsen[3]

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

Because radio waves do not travel well through good electrical conductors like salt water, submerged submarines are cut off from radio communication with their command center at ordinary radio frequencies. Very low frequency (VLF) radio waves can penetrate seawater a few hundred feet, and many navies use powerful shore VLF transmitters for submarine communications. Australian NWC (North West Cape) signal transmitter is known to strongly interfere with the topside ionosphere. Recently, Mishin et al. (2010) concluded that interactions between the NWC signal and ionospheric plasma resulted in nonlinear plasma instabilities, giving rise to turbulence, and ultimately causing a loss of VLF signal. Xia et al. (2020) found that these effects are strongest on the nightside and during times with a low ambient electron density. Němec et al. (2020) likewise used data from the DEMETER satellite, and found evidence for enhanced electric-field waves, in addition to perturbations in electron density and temperature associated with NWC, around a large area situated 400km north of NWC. In addition, Ivarsen et al. (2021) analyzed the Swarm A, B and NorSat-1 satellite data. Through high frequency plasma density observations, they present a scale-dependent characterization and climatology of strong plasma fluctuations induced by the NWC transmitter, with a seamless local time coverage. In this study, using the ROCSAT-1, COSMIC-2 and ICON data, we will analyze characteristics and morphology of plasma perturbations around the NWC site.

제1발표장 Convention I

Ⅳ-1 태양 및 우주환경 Ⅳ

Chair: 이창섭 (극지연)

13:00 [Ⅳ-1-1]

Space Radiation Dosimetry in Low-Earth Orbit: The LEODOS Instrument on Board the NEXTSat-2

Uk-won Nam[1], Won-Kee Park[1], Sukwon Youn[2], Bong-Kon Moon[1], Jongdae Shon[1], Young-Jun Choi[1], Jeonghyun Pyo[1], Jaejin Lee[1], Junga Hwang[1,3], Sunghwan Kim[4], Sung-Joon Ye[2], Hongyoung Park[5], Taeseong Jang[5], Jungho Kim[6]

[1]*Korea Astronomy and Space Science Institute*
[2]*Radiological Physics Laboratory, Seoul National University*
[3]*University of Science and Technology*
[4]*Department of Radiology, Cheongju University*
[5]*Satellite Technology Research Center, KAIST*
[6]*Korea Research Institute of Standards and Science*

Space radiation dosimetry presents one of the greatest challenges in the discipline of radiation protection. This is due to the highly complex nature of the radiation fields encountered in low-Earth orbit (LEO) and interplanetary space, as well as the constraints imposed by spaceflight on instrument design. The LEO-DOS instrument on board the NEXTSat-2 (the Next Generation small satellite-2), which is scheduled to be launched in the first half of 2023 by means of the Nuri KSLV-III, is an innovative device designed to measure radiation levels in LEO. The main missions of the LEO-DOS instrument are to create a global map of doses by charged particles and neutrons, and to measure the human impact weight by neutron energy bands. To accomplish this mission, the LEO-DOS is equipped with a tissue-equivalent particle detector and a fast neutron dosimeter. All instrument calibration was done with check-sources in the laboratory. A precise dose calibration of low-LET and high-LET was conducted with Cf-252 in KRISS for neutrons and in KORASOL for gamma rays, respectively. The LEO-DOS mission is a cutting-edge technology that plays a vital role in the study of space radiation dosimetry. It has wide-ranging applications in different fields. The main space application of LEO-DOS will be to the DALO:LVRAD (Lunar Vehicle Radiation Dosimeter) project, which is one of the proposed instruments for CLPS in Korea. This project will investigate the radiation environment of the Moon's surface. This work was supported by the National Research Foundation of Korea (NRF) Grant funded by the Korea government (MSIP) (NRF-2017M1A3A4A01077173) and (NRF -2020M1A3B7108845).

13:15 [Ⅳ-1-2]

Latitudinal Variations on Thermospheric Winds and Temperatures over Arctic Area under Different Geomagnetic Conditions

Changsup Lee[1,2], Geonhwa Jee[1,2], Qian Wu[3], Young-bae Ham[1,2], Jeong-Han Kim[1], Hyuck-Jin Kwon[1], Jieun Kim[1]

[1]*Korea Polar Research Institute*
[2]*University of Science and Technology*
[3]*NCAR - High Altitude Observatory*

Polar thermospheres actively interact not only with solar wind particles but with those from the Earth's magnetotail. As a geometry of the Earth's magnetic field highly rely on geomagnetic latitude, it is necessary to study on thermospheric responses to geomagnetic activities by simultaneous thermospheric measurements. Korea Polar Research Institute has been observing high latitude thermosphere winds and temperatures using ground-based Fabry-Perot Interferometers (FPIs) since 2016. In this study, we use two FPIs located at Resolute Bay, Canada and Kiruna, Sweden representing polar cap and sub-auroral region, respectively for studying latitudinal difference in thermospheric winds and temperatures. We also used ionospheric plasma velocities from simultaneous EISCAT radar observations at Kiruna to show how ionospheric convection and thermospheric wind can be related each other.

13:30 [Ⅳ-1-3]

Forecast of Major Solar Flare Using Deep Reinforcement Learning for Imbalanced Classification

Kangwoo Yi[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[1]

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

In this study, we present the application of deep reinforcement learning to the forecast of solar major flares. For this, we consider full-disk magnetograms at 00:00 UT from Solar and Heliospheric Observatory/Michelson Doppler Imager (1996–2010) and Solar Dynamics Observatory/Helioseismic and Magnetic Imager (2011–2019), as well as Geostationary Operational Environmental Satellite X-ray flare data. We apply Deep Q-Network (DQN) and Double DQN, which are popular deep reinforcement learning methods, to predict "Yes or No" of daily flare occurrence for M- and X-class. The reward functions, consisting of four rewards for true positive, false positive, false negative, and true negative, are used for our models. Major results of this study are as follows. First, our deep learning models successfully predict major solar flares with good skill scores such as HSS, F1, TSS, and ApSS. Second, the performance of our models depends on reward function, learning method and target agent update time. Third, the performances of our deep learning models are noticeably better than that of a Convolutional Neural Network (CNN) model with the same structure: 0.38 (CNN) to 0.44 (ours) for HSS, 0.47 to 0.52 for F1, 0.53 to 0.59 for TSS, and 0.09 to 0.12 for ApSS.

13:45 [Ⅳ-1-4]

Preliminary Design of the GrainCams Payload for the Lunar Rover

Woojin Kim[1,2], Bongkon Moon[1,2], Dukhang Lee[1], Dae-Hee Lee[1], Min-Bae Kim[1], Minsup Jeong[1], Jihun Kim[1], Seonghwan Choi[1], Jehyuck Shin[1], Mingyeong Lee[1,2], ChaeKyung Sim[1], Young-Jun Choi[1,2], Sungsoo S. Kim[3]

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

The KASI has been developing GrainCams, which is the lunar rover payload for the Commercial Lunar Payload Services (CLPS) project. GrainCams is a suite of two cameras called SurfCam and LevCam. The objective of SurfCam is to detect the fairy castle, which is the microstructure on the lunar regolith, while LevCam is designed to observe the levitating dust at the upper part of the lunar surface. The GrainCams should operate in the lunar environment without degradation. Therefore, this payload needs to maintain a temperature within the operating range of −20℃ to 60℃. We present the preliminary opto-mechanical design and some results of structural analysis to verify the stability of the payload. Additionally, we present thermal analysis results that were conducted to confirm the temperature range and radiator thermal effect in each phase of the mission.

14:00 [Ⅳ-1-5]

A Solar Limb Flare Model Using SDO/AIA EUV Limb Intensity

Jaewon Lee[1], Yong-Jae Moon[1,2], Hyun-Jin Jeong[2], Harim Lee[2]

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

For the first time, we present a solar limb flare model using SDO/AIA data. It is well known that there are several problems (such as projection effects) in white light and magnetogram data near the limb. We are setting up an empirical probabilistic model of solar limb flares within a day. For this we use two SDO/AIA channel data (94 Å and 131 Å) corrected for the degradation of detectors. In this study we analyze 103 major (≥ M 1.0) limb (≥ |60°| in longitude) flares in GOES flare catalog and SDO/AIA data from 2010 to 2022. We define the limb intensity of SDO/AIA data as the summation of intensities over the limb region, which is used as input data. Then we compare the limb intensities for both flaring cases and non-flaring cases. Major results can be summarized as follows. First, the fractions of major flares strongly depend on both limb intensities. Second, the largest probability of major flares for 94 Å is about 25% when log I is larger than 5.8, while that for 131 Å is about 10% when log I is larger than 6.4. Third, the smallest probability for 94 Å is about 0.2 % when log I is smaller than 5.4, while the smallest one for 131 Å is about 0.2 % when log I is smaller than 6.2. Our study shows a sufficient possibility that the empirical solar limb flare model can be set up by using solar EUV data.

제3발표장 301호

Ⅳ-3 달과 우주탐사: 과학과 기술 그리고 정책/초소형위성

Chair: 서행자 (한컴인스페이스)

13:00 [Ⅳ-3-1]

Statistical Study of Low Energy Ions Originated from the Lunar Dayside in the Terrestrial Magnetotail Lobe

Jaehee Lee[1], Khan-Hyuk Kim[1], Seul-Min Baek[2], Jong-Woo Kwon[1], Ho Jin[1], Jonghoon Lee[1], Ensang Lee[1], Yoshifumi Saito[3], Masaki N. Nishino[4], Shoichiro Yokota[5]

[1]*Kyung Hee University, Korea*
[2]*Korea Astronomy and Space Science Institute*
[3]*Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency*
[4]*Tokyo University, Japan*
[5]*Osaka University, Japan*

Tanaka et al. (2009) reported that Moon-originating ions are generated by solar photon driven processes. However, there have been no statistical studies of Moon-originating ions. We have studied the statistical properties of low-energy ions originated from the dayside of the Moon using Kaguya data for 2008–2009 when the Moon was in the terrestrial magnetotail lobes. These lunar origin ions were detected in the energy range of 20–2000 eV observed at ~100 km altitude on the dayside. They mostly consist of heavy ions such as C^+, O^+, Na^+, Al^+, K^+, and Ar^+ and are distributed in a range of 50–130 degrees to the background magnetic field. In order to understand where and how Moon-originating ions are generated, we examine the relationship between energy and pitch angle and between energy and solar zenith angle. We found that the occurrence of the Moon-originating ions is high near Mare Nubium. To examine the observed energy and pitch angle of the lunar origin ions, test particle trajectory calculation is performed by assuming that the lunar origin ions detected at Kaguya orbit are energized by the electrostatic potential difference of 200 V between Kaguya and Moon. The particle calculation demonstrates that the initial speed of the ionized ions near the lunar surface plays a significant role in determining the observed pitch angle.

13:15 [Ⅳ-3-2]

Zero Offset Determination Study of KMAG Aboard KPLO Using MVA Method in the Solar Wind

Hyeonhu Park[1], Ho Jin[1], Kwan-Hyuk Kim[1], Wooin Jo[1], Seul-Min Baek[2], Junhyun Lee[1], Yunho Jang[1]

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

The KPLO-Magnetometer (KMAG) is one of the Korea Pathfinder Lunar Orbiter (KPLO)'s payloads. The KPLO, also known as Danuri, is currently orbiting the Moon after launching on August 5, 2022. In situ measurement data of magnetic field include the ambient field, the instrument offset, and the magnetic disturbance generated by spacecraft. Therefore, calibration is required to remove unwanted magnetic fields. Many methods have been developed to determine the zero offset for in-flight calibration of magnetometer. Even if the properties of Alfven waves, mirror mode structures, or current sheets are not sufficiently detected, zero offset can be calculated using the interplanetary magnetic field (IMF) fluctuations. Here, we present a method of calculating the zero offset using several offset cubes with the possible range of IMF strength. In the previous study, one offset cube was used, which has a fixed step length, but in this study, several offset cubes with different the step length were used to reduce computing time. When there is enough IMF variation events in the magnetic field data, the distribution of mean B_L (maximum variance direction) determined by minimum variance analysis (MVA) follows the normal distribution. The standard deviation of a normal distribution has the minimum as it is close to zero offset in the offset cube. We then compared the test results of the offset applied KMAG data to DSCOVR magnetometer data when KPLO was in the Ballistic Lunar Transfer (BLT) trajectory. The results show that the average and standard deviation of the two data during the day are similar. In this work, we provide the one of the calibration methods of KMAG data.

13:30 [Ⅳ-3-3]

Stray Light Analysis of Volume-Sharing Multi-Aperture Payload for Earth Observation

Sehyun Seong[1,2], Seonghui Kim[1,2], Jun Ho Lee[3], Myoungjoo Kang[4], Sug-Whan Kim[2]

[1]*TelePIX Co., Ltd.*
[2]*Department of Astronomy, Yonsei University*
[3]*Department of Optical Engineering, Kongju National University*
[4]*Department of Mathematical Sciences, Seoul National University*

A satellite payload is currently under development that will use multiple cameras, including three narrow field-of-view (FOV) cameras and one wide-FOV camera, to simultaneously observe the Earth and combine the acquired images to achieve a 1m ground sample distance (GSD) at an altitude of 500 km. This approach, called Multi-Aperture Computation Camera, overcomes the spatial resolution limitations imposed by the size of the optical system. However, the use of multiple cameras in a single payload creates challenges related to the intersection of their rays and the need for multiple mirrors and lenses to achieve long focal lengths, making it difficult to install appropriate baffles. Additionally, since the narrow-FOV cameras have smaller entrance apertures than conventional telescopes, they have lower signal-to-noise ratios and are more susceptible to stray light. This presentation focuses on the analysis of the effects of stray light from external light sources on a volume-sharing multi-aperture payload with the structural characteristics mentioned above. We used backward ray tracing computation to identify critical, intervening, and illuminated objects and applied weights to the locations of external light sources during this process. We then simulated the point source transmittance (PST), a metric that indicates the camera's stray light rejection performance, using forward ray tracing computation with the weights of external light sources. In addition, we assumed an arbitrary radiance distribution within the observation area, calculated the irradiance distribution of stray light that could reach the detector using radiative transfer computation, and analyzed the impact of stray light on imaging and radiometric performance. This presentation provides insights into the challenges associated with using multiple cameras in a single payload and the impact of stray light on the image quality of such systems.

13:45 [Ⅳ-3-4]

Pre-Flight Calibration and Early Operation Results of PolCam

Minsup Jeong[1], Young-Jun Choi[1,2], Sungsoo S. Kim[3], Bongkon Moon[1], Chae Kyung Sim[1], Kyung-In Kang[4], BonJu-Gu[4]

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

Danuri which is the first Korean lunar orbiter launched on August 5, 2022 has a polarization imager called the Wide-angle Polarimetric Camera (PolCam). Its objective is to create photometric and polarization maps with a spatial resolution of less than 100 m, at wavelengths of 336 nm, 461 nm, and 748 nm, over a phase angle range of 0°–135°. PolCam uses the Push-broom method and has two cameras, each with a viewing angle of 45° to the right and left of the spacecraft's direction of orbit. Prior to its installation on the spacecraft, performance

tests were conducted in the laboratory to assess various parameters, including CCD's dark current, flat field frame, spot size, and light flux. The laboratory data obtained was used for sensitivity correction and data processing. Cam 1 and Cam 2 had an average dark current of 72.84 ADU and 76.59 ADU, respectively, when measured at 293.15K. The spot size (full width half maximum) at PolCam's normal operation mode was 1.23 for Cam 1 and 1.08 for Cam 2. In addition, we will present initial findings from PolCam's early operations along with a preliminary analysis of the collected data.

제1발표장 Convention I

Invited Talk II

Chair: 최기혁 (항우연)

14:30 [IS-II]

The Era of Space Economy and the Role of Korea Aerospace Research Institute

Sang-Ryool Lee

Korea Astronomy and Space Science Institute

Looking back, 2022 was a year with many moments that will be recorded forever in the history of space development in Korea.

Korea's first lunar probe Danuri, which was successfully launched in August 2022, In December of that year, the mission began in earnest after entering safely in the lunar mission orbit. By applying the 'Ballistic Lunar Transition Trajectory (BLT)', which was first attempted in Korea, on the way to the sun and then to the Moon, at a distance of 1.24 million km the photo was taken with a high-resolution camera developed by the Korea Aerospace Research Institute. Looking at the pictures of the Earth and the Moon together, all the people felt a sense of overwhelming emotion.

The successful launch of Danuri is the first step in the journey to the Moon, it is a signal flare announcing the beginning of the era of space exploration in Korea. Prior to this, in June, the Korean Space Launch Vehicle Nuriho (KSLV-2). It was launched successfully, receiving cheers from all over the country. Looking at the dark red flames and smoke emitted by the Nuri at the time of launch, looking at the signal announcing that we have finally entered normal orbit, all Koreans were thrilled.

In 2023, our challenge to the space continues, for the realization of the Korean space economy promoted by the government. By laying the groundwork for a new leap in consideration of the space development 2.0 policy, the journey to enter a full-fledged space advanced country continues.

In the SBAS development division, aiming to provide aviation service of ultra-precision GPS correction system, we are conducting R&D, Korean ultra-precision GPS correction system KASS (Korean Augmentation Satellite System) interlocking test between ground segment and KASS aeronautical satellite No. 1 is in progress. In February 2023 interlocking test of ground system and satellite system and in November when performance conformance is completed, from January 2024 KASS signals will be broadcasted throughout Korea. We will start in earnest in aviation service.

The KPS Development Project Headquarters signed an R&D project agreement in 2022 and officially launched in July, total of 8 satellites and terrestrial user systems will be built. 2023 is the year when KPS satellite navigation system development will begin in earnest as holding a system design review meeting (SDR) and we are going to start in practice for international cooperation for international registration of KPS satellite network. Launch vehicle development field, in June 2022, the second launch of the Nuri was successfully carried out. In the first half of 2023, the Korean launch vehicle development project is scheduled to end. From May 2022, before the second launch of the Nuri the project to upgrade the Korean launch vehicle has already begun. The third launch of the Nuri is scheduled on May 10 next month. As part of the Korean launch vehicle performance enhancement project, the first launch will be conducted by Hanwha Aerospace. I believe that the production and launch of a Nuri (KSLV-2) is also a meaningful event led by domestic industries.

By successfully carrying out the 6th launch in 2027 increasing the reliability of the Korean launch vehicle and focusing on system integration companies we will contribute to fostering industries related to launch vehicles in Korea. In the first half of 2023 according to the need to develop a more advanced and larger launch vehicle than the Nuri passed the preliminary economic feasibility study in November 2022, a project to develop a next-generation launch vehicle is also planned. The next-generation launch vehicle is expected to have about three times the performance of the Nuriho. It is expected to be able to send a 1.8-ton lunar lander. On the other hand, a small launch vehicle system linked with Nuriho technology and low-cost and reusable core prior technology research is also being conducted. In the future, technical support from private companies in the field of launch vehicles and satellite multiple injection using a small launch vehicle, we will also conduct prior technology research for deep space exploration missions. Lunar exploration, Korea's first lunar orbiter Danuri was launched on August 5, 2022. After a long journey of nearly 6 million km for about 5 months, successful entry into lunar mission orbit was achieved. Through this preparations for full-scale lunar exploration have been completed. In January 2023, the test run of Danuri was successfully completed. through the normal operation of six payloads by December Korea's first lunar exploration mission will be carried out.

At the Future Innovation Research Center, for advanced research to secure innovative technologies for future aerospace, conducted future challenge innovation research. Through this, space solar power generation, space robots, space laser communication, D-Cube Lab, deep space communication field, etc., we are concentrating on laying the groundwork for the development of innovative future space technology. In 2023, the 2nd year task of future challenge innovation research will be carried out, through this we will enhance the perfection of innovative future space technologies in each field.
In November 2022, our government announced the 'Future Space Economy Roadmap', which contains the policy direction by 2045 to become a space economy powerhouse. Then in December 2022, the '4th Space Development Promotion Basic Plan' was finalized by the National Space Council, This includes landing on the moon in 2032 and starting resource mining, in 2045, the 100th anniversary of liberation, an unmanned landing on Mars will be pursued, while possessing independent space exploration capabilities, and securing manned space launch capability by 2045, it contains grand plans.
In order to open the era of space economy in Korea, with the mind set of becoming a new growth engine for Korea, the KARI and government-funded research institutes, industries, and universities will work together. We will have to continue with greater challenges and fruits.

제1발표장 Convention I

Invited Talk III

Chair: 이우경 (천문연)

15:10 [IS-III]

BioCabinet (Bio 3D Printing and 3 Dimensional Culture System) for Space Biomedicine

Chan Hum Park[1,2,3], Young Jin Lee[2], Ji Seung Lee[2]

[1]*Hallym University Medical Center*
[2]*NanoBio Regenerative Medical Institute, Hallym University*
[3]*Otorhinolatyngology-HNC in Chuncheon Sacred Heart Hospital, Hallym University*

In recent years, space medicine and biology have been gaining attention due to plans such as human residency on the moon and long-term exploration of Mars. However, there is hardly any research on this subject in Korea, BioCabinet (3D cell culture and bio 3D printer system) for space life science research will be carried and launched on board CAS500 through the Nuriho-3 in 2024.
Biocabinet aims to conduct research on the most critical cardiovascular diseases in astronaut through 3D printing of cardiac stem cells and 3D vascular differentiation culture of stem cells.
Thus, we would like to introduce the development process of Biocabinet and provide an overview of space biomedical engineering.

15:50~18:00 포스터 발표

4월 28일(금) **제1발표장 Convention I**

V-1 태양 및 우주환경 V

Chair: 이원석 (연세대)

09:00 [V-1-1]

The Impacts of Lower Atmospheric Variabilities on the Ionosphere Using SD-WACCM-X during Two Geomagnetic Storms: April 2010 and March 2013

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

Department of Atmospheric Sciences, Yonsei University

This study focuses on understanding the lower atmospheric effects on the ionospheric tides. We carried out six experiments using Specified dynamics version of the Whole Atmosphere Community Climate Model with Thermosphere and Ionosphere Extension (SD-WACCM-X) during two geomagnetic storm events: April 2010 and March 2013. In the first experiment, the lower atmospheric dynamics are nudged by the Modern-Era Retrospective analysis for Research and Applications (MERRA) version 2 reanalysis data during the full period of experiment. On the other hand, the remaining experiments are performed without specified dynamics 20 days, 10 days, 5 days, 2 days, and 1 day before the storm starts, respectively. We compared the tidal variabilities in total electron contents (TEC) from the simulations and compare with those from Global Ionospheric Maps (GIM) TEC, which can lead to understand the influence of lower atmospheric variabilities on the ionospheric tides. The detailed results will be discussed in the presentation.

09:15 [V-1-2]

Effect of Ion Drag on Thermospheric Neutral Dynamics during Wintertime in Southern Polar Cap

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

Jeong-Han Kim[1], Qian Wu[3], Nikolay Zabotin[4], Terence Bullett[5]

[1]*Division of Atmospheric Sciences, Korea Polar Research Institute*
[2]*Department of Polar Sciences, University of Science and Technology*
[3]*High Altitude Observatory, National Center for Atmospheric Research*
[4]*Department of Electrical and Computer Engineering, University of Colorado Boulder*
[5]*Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder*

It is well known that the thermospheric neutral dynamics is mostly governed by neutral pressure gradient and ion drag forces. Unlike the neutral pressure gradient force the ion drag force generally plays a different role depending on the geomagnetic latitudes. To the thermospheric constituents, the ionospheric plasma act as a load in the low and middle latitudes, whereas they can drive the motion of neutrals in the polar region as a drag force, resulting in sunward or anti-sunward motion in the auroral oval or polar cap region, respectively, in association with plasma convection which is induced by magnetospheric electric field. To investigate the effects of the ion drag force on the thermospheric neutral winds during wintertime, we analyzed the ion drift and thermospheric wind data obtained from the simultaneous thermospheric and ionospheric observations at Jang Bogo station (JBS), Antarctica. We found that the neutral winds are observed to be larger at around the MLT midnight than the MLT noon and it can probably be explained by the fact that the neutrals have been forced by ions longer at midnight than at noon. It is also found that the neutral winds more sensitively respond to the ion flows on the MLT dusk sector than on the MLT dawn sector, and the electron density measurement suggests that high ion density on the MLT dusk sector is responsible for this.

09:30 [V-1-3]

The Effect of Transition Region on the Umbral Oscillations

Soo-Sang Kang, Jongchul Chae

Seoul National University

Umbral oscillations in the solar chromosphere have been studied consistently to understand the physics of the solar atmosphere. Recently the resonator model paid attention to acoustic highpass-filtering at the temperature minimum and gave an theoretical description of the three-minute umbral oscillation. Here we point out the transition region which shows a sharp temperature rise so that can be a reflective layer. An analytical interpretation assuming a linearly propagating acoustic wave in the non-isothermal atmosphere including the transition region is constructed. As a result, we can reproduce the multi-peak power spectrum of Doppler shift velocity in the H-alpha line, which appears by acoustic filtering and resonance in the cavity between the temperature minimum and the transition region.

09:45 [V-1-4]

First Observation of the Possible Vertical Coupling between D-Region Convective PMSE Fast Flow and Pulsating Aurora

Young-Sook Lee[1], Yukinaga Miyashita[2,3], Akira Kadokura[4], Ram Singh[1], Young-Sil Kwak[2,3], Yong Ha Kim[1], Mark Lester[5]

[1]*Chugnam National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*University of Science and Technology*
[4]*National Institute of Polar Research (NIPR), Japan*
[5]*University of Leicester, United Kingdom*

We report a new possible feature of polar mesospheric summer echoes (PMSE) to be a vertical extension of pulsating aurora with drifting along the ionospheric plasma convection. It is observed as post-midnight eastward fast flows in the D-region ionosphere during moderate substorms using SuperDARN radars located at Pykkvibaer, Iceland. The eastward velocities of PMSE were sustained for 40–50 min, varying up to 200 m/s. The high velocity echoes continued to propagate northeastward to higher latitudes/E-F region altitudes, lasting ~4 h. The relevance of pulsating aurora patches are strengthened by the recurring eastward propagating auroral patches observed at Syowa, Antarctica, a conjugate station. The PMSE eastward fast flow may represent the motion of pulsating aurora with vertical coupling between the D-region PMSE patch and E-region pulsating aurora.

10:00 [V-1-5]

Capella: A Space-Only High-Frequency Radio VLBI Network Formed by a Constellation of Small Satellites

Sascha Trippe

Seoul National University

Very long baseline radio interferometry with ground-based observatories is limited by the size of Earth, the geographic distribution of antennas, and (at high frequencies) the transparency of the atmosphere. We present *Capella*, a tentative design of a space-only VLBI system. Using four small (less than 500 kg) satellites on two orthogonal polar low-Earth orbits, and single-band heterodyne receivers operating at frequencies around 690 GHz, the interferometer is able to receive angular resolutions

of approximately 7 microarcsec. Within a total observing time of three days, a near-complete uv-plane coverage can be reached, with a 1-sigma point source sensitivity of about 5 mJy for an instantaneous bandwidth of 1 GHz. Downlink data rates higher than 10 Gbps can be reached through near-infrared laser communication. We note that all key technologies required for the *Capella* system are already available. Science cases are photon rings around supermassive black holes, the acceleration and collimation zones of plasma jets emitted from the vicinity of supermassive black holes, the chemical composition of accretion flows into active galactic nuclei through observations of molecular absorption lines, and the magnetic activity of stars.

제2발표장 Convention II

V-2 달과 우주탐사: 과학탐사를 위한 대기권 재진입 (ARES)

Chair: 이덕행, 문홍규 (천문연)

09:00 [V-2-1]

Heat Protection for Reentry Vehicle into Earth's Atmosphere

Hyo Keun Ahn

Agency for Defense Development

Recently, space exploration becomes an issue relating to establish space-involving division of the government. Up to now, space exploration has been done mainly by several countries; United States, Russia, Japan, etc. Among many activities of space exploration, reentry of space vehicle into Earth's atmosphere is the final step to complete space projects. When a space vehicle is entering into Earth's atmosphere, it experiences hypersonic speed which causes severe aerothermo-dynamic environment. Without measures to protect the vehicle, it is definitely not possible to let the vehicle land to ground safely. TPS (thermal protection system) should be provided for safe landing of the entering vehicle.

In the study, various aerodynamic phenomena occurring in atmospheric entry with hypersonic speed, technologies for the design of TPS, and etc are introduced.

09:15 [V-2-2]

A Study on the Seasonal, Daily and Geographical Variability of Physical Parameters of Upper Atmosphere between 100-300 Km for Reentry Trajectory Analysis

Gi-Hyuk Choi[1], Won-Seok Lee[2], Dae-Yeong Kim[1]

[1]*Satellite & Space Exploration Systems Engineering and Architecture R&D Divison, Korea Aerospace Research Institute*

[2]*Department of Atmospheric Science, Yonsei University*

KARI and Chung Nam National University developed a upper atmosphere modelling S/W. It is combined two existed models. We produce a database between 0–300km by means of using th European ECMWF model for lower atmosphere between 0–80 km and American NRLMSISE-00 Model for upper atmosphere between 80–300 km. The database has vertical atmosphere parameters such as temperature, density, pressure, mean molecular mass and chemical compositions with respect to every 5 km in altitude, every 5° in geophysical location and every hours in time. The S/W is interpolating the database with a certain time, altitude and geographical location. Usually reentry is told to start from 120 km altitude and lower atmosphere is not changed very much through geographically and temporally, however it is also known that the reentry trajectory is somehow affected by upper atmosphere. Therefore in this study we will look at the variability of physical parameters in upper atmosphere between 80–300 km altitude.

09:30 [V-2-3]

Introduction to Guidance Techniques for Reentry Vehicles

Chang-Hun Lee

Korea Advanced Institute of Science and Technology

This paper aims to introduce guidance techniques for reentry vehicles. The back-to-turn (BTT) control mechanism is utilized in most reentry vehicles. The angle of attack is regulated in a way to follow the predetermined profile, and the bank angle is used as the guidance command. This paper discusses two guidance techniques based on reference drag following and the convex optimization approaches to determine the desired bank angle command. In the first method, a reference drag profile that satisfies various flight constraints is determined so that the drag force of the reentry vehicle follows the reference drag profile. The second approach determines a bank angle command that satisfies various flight constraints by directly solving the optimization problem. This paper also discusses the characteristics and advantages of each guidance technology.

09:45 [V-2-4]

Statistical Solution Algorithm for Multiscale Gas Flow at All Knudsen Numbers: Hypersonic Reentry Flow

Eunji Jun

Korea Advanced Institute of Science and Technology

Rarefied Gas Dynamics has been extensively studied last

several decades. The degree of rarefaction and departure from transitional thermal equilibrium of a gas is generall characterized through the Knudsen number, $Kn = \lambda/L$, where λ is mean free path of the gas and L is a characteristic length scale. The flow regime is classified as free molecular, continuum, and transitional, depending on the Knudsen number. There are many flows exhibiting large variations of molecular mean free path length in the aerospace. For example, hypersonic entry/re-entry flow over a blunt body and rarefied plume flow experience a wide range of molecular mean free path lengths. In these multiscale flows, conventional Navier-Stokes-Fourier description, on which continuum flow solvers are based, breaks down where the Knudsen number becomes large. Rarefied flow condition should be considered and flow description needs to be directly based on the Boltzmann equation, which recognizes a gas flow as a microscopic or molecular level. Boltzmann equation is not amenable to analytical solution, and it presents overwhelming difficulties to conventional numerical methods due to non-linearity of the collision operator and the high dimensionality of the solution domain. Therefore, it is important to develop accurate and efficient numerical schemes to solve Boltzmann equation for the flow involving rarefied gas. It this colloquium, numerical analysis for both equilibrium and non-equilibrium flows based on statistical methods; Direct Simulation Monte Carlo (DSMC), Low Diffusion (LD), and Fokker-Planck (FP) will be discussed. Novel 'all-particle' schemes are applied to aerospace problems; hypersonic entry/re-entry flows and rarefied plume flow.

10:15 [V-2-5]

Enabling Earth Atmospheric Reentry Missions for Thermal Protection System Technology Demonstration

Hyeonjun Kim[1], Jaesung Shin[1], Daeban Seo[1], Keejoo Lee[1], Beomseok Oh[1], Jaesung Park[1], Sungwon Kim[2]

[1]*Korea Aerospace Research Institute*
[2]*Korea Institute of Ceramic Engineering and Technology*

The spacecraft experiences rapid deceleration, converting kinetic energy to thermal energy, when it enters the atmosphere of a planet or moon. A Thermal Protection System (TPS) is indispensable to protect onboard payload and the vehicle itself from the extreme conditions of atmospheric entry and to safely deliver them to the planetary surface. A wide range of science missions that involve the TPS technology are getting increasingly more attention as an independent access to space is now available with the Nuri program and the succeeding one. KARI currently is developing both reusable and ablative TPS systems similar to TUFROC and PICA, respectively. The reusable TPS is for a future space plane while the ablative one is for reentry capsules used in sample return missions to the moon and asteroids. Developing the TPS requires interdisciplinary collaboration among materials science, physics, chemistry, aerothermal engineering, and computational modeling. The performance of new TPS materials must be verified under extreme conditions that are comparable to the actual reentry, which is usually achieved only by a demonstration flight mission. For this, spacecraft and other test vehicle such as a kick stage are equipped with a reentry capsule, and launched into space. Then, the new TPS system is tested when these vehicles reenter the Earth's atmosphere. Therefore, a demonstration mission is always required to validate and verify new TPS systems for future reentry applications. Small Launcher R&D Department at KARI is considering the development of a small launch vehicle and an orbiter, which could be used for a reentry mission with a demonstrator capsule.

10:30 [V-2-6]

Atmospheric Entry Flight of Planetary Vehicle and Ground Testing

Jae Jeong Na

Agency for Defense Development

Planetary vehicle returning from the Moon, Mars or asteroids will enter Earth's atmosphere at a super-orbital velocity. At such a high velocity, a strong shock wave is formed in front of the re-entry vehicle and uncertainties exist on the interaction of heating and ablating environment. For this reason, an effort must be made to investigate whether this phenomenon is produced in the Earth-returning flight which is expected to be carried out in the near future. This is a work to help the overall understanding of the phenomenon that occurs when a planetary vehicle enters the atmosphere. Thus, the present work includes; First, the non-equilibrium flows, aerodynamic heating, and heat & mass transfer phenomena that occurs when a planetary vehicle enters the atmosphere or conducting a ground test are explained. And second, we investigate the effect of these phenomena on the mission profile and heatshield constituting the surface of the planetary vehicle when it enters the atmosphere. Finally as an application example, we present predictions and analysis results for aerodynamic heating and heatshield ablation assuming lunar return flight to Earth. This predicted results will be a requirements of the ground and flight tests if we plan to Earth return flight of planetary vehicle in the near future.

10:45 [V-2-7]

Introduction of the Aerothermodynamic Heating on the Atmospheric Entry Vehicles and It's Related Research Topics

Jae Gang Kim

Sejong University

In space exploration projects, such as asteroid sample return, the process of re-entering into the Earth's atmosphere need to be accompanied. In the process of re-entering into Earth, the space vehicles experience the aerothermodynamic heating accompanied by very complex thermal physics phenomena, named as hypersonic nonequilibrium aerothermodynamics. In the case of the asteroid sample return mission, the re-entry speed into Earth is close to 14 km/s, and in this extreme reentry environment, the maximum surface heat flux on the space vehicles reach close to 10 MW/m^2, and the heat load on the vehicle is about 270 MJ/m^2 after 80 seconds from the ballistic re-entry. In this study, the aerothermodynamic heating mechanisms will be introduced, and the related research totpics about the TPS heat shield design and the numerical prediction of the surface heating also will be introduced.

11:00 [V-2-8]

Fabrication and Characteristics of Porous Ceramic Materials for Reusable TPS Applications

Seongwon Kim[1], Min-Soo Nam[1,2], Yoon-Suk Oh[1], Sahn Nahm[2], Jaesung Shin[3], Hyeonjun Kim[3], Bum-Seok Oh[4]

[1]*Engineering Materials Center, Korea Institute of Ceramic Engineering and Technology*
[2]*Department of Materials Science and Engineering, Korea University*
[3]*Small Launcher R&D Office, Korea Aerospace Research Institute*
[4]*Launcher Thermal and Aerodynamics Team, Korea Aerospace Research Institute*

Thermal protection systems (TPS) are group of materials essential in order to protect spacecraft from the aerodynamic heating experienced during re-entry into an atmosphere. Among candidate materials for TPS applications, porous ceramic materials are ones for reusable TPS.
In this study, we report the development of ceramics insulation materials, such as AETB (Alumina Enhanced Thermal Barrier), which are fabricated by using ceramic fiber and additives via typical ceramics processing. Some issues on processing difficulties are reported in order to produce properly formed RSI (Reusable Surface Insulation).

제3발표장 301호

V-3 SS: 과측위성 탑재체 기술 확보방안

Chair: 천이진 (항우연)

09:00 [V-3-1]

An Introduction of Geostationary Ocean Color Imager System

Geumsil Kang, Jeoung Heum Yeon, Jongguk Choe, Won Beom Lee, Jeeyeon Yoon, Ilseop Lee, HaengPal Heo

Korea Aerospace and Research Institute

The ocean color monitoring mission around the Korean Peninsula from a geostationary platform has been performed by GOCI-II (Geostationary Ocean Color Imager-II) since 2020. In case of GOCI-I, it had provided the monitoring mission since 2010 and its mission was finished at 2021. KARI had developed GOCI-I and GOCI-II through a joint development with Airbus Defense & Space. Domestic development of the next geostationary ocean color imager is requested based on the technology accumulated through the GOCI-I and the GOCI-II program.
In this paper, GOCI system is introduced from the development point of view. In comparison to a low earth orbit payload, the GOCI applies special concepts of measurement operation thanks to a geostationary platform. The GOCI system configuration is designed based on the mission operation concept. There are major requirements which drives H/W design; a high SNR (signal to noise ratio) is requested to detect a weak variation of ocean radiance. Multi-spectral measurements are necessary to monitor ocean color and to perform atmospheric correction. On-board calibration is also required for the radiometric correction. There are three mechanism units in order to support the operation concept; a pointing mirror mechanism to cover a requested FOR (Field of Regard) including a star imaging for INR (Image Navigation & Registration) processing, a filter wheel mechanism carrying optical filters, and shutter wheel mechanism with on-board calibration devices. In this paper, major uints of GOCI will be introduced in terms of functions and major requirements.

09:15 [V-3-2]

GEMS Operation Status and Mission Plan for the Next Environmental Satellite

Jaehoon Jeong[1], Kyung-Jung Moon[1], Dongwon Lee[1], Hanlim Lee[2], Dai-Ho Ko[3]

[1]*National Institute of Environmental Research*
[2]*Pukyoung National University*
[3]*Korea Aerospace Research Institute*

The National Institute of Environmental Research (NIER) launched the geostationary environmental monitoring spectrometer (GEMS) on February 19, 2020, to monitor the movement of air pollutants and climate change triggers over Asia. GEMS is the world's first hyperspectral payload operating in geostationary orbit to monitor environmental conditions. Currently, GEMS observes air quality in Asia every hour, on average 8 times a day, and monitors a total of 21 level 2 (L2) products, including aerosols, nitrogen dioxide, and ozone. The resultant data is accessible through the GEMS website (https://nesc.nier.go.kr) within an hour after each observation. In addition to these L2 outputs, 5 types of L4 output, such as the aerosol movement, and the concentration of ground fine dust, are also released. GEMS outputs are used in many applied contexts, including monitoring air pollutants, air quality forecasting, and responding to environmental disasters, such as forest fires and volcanoes. To continue this work, a follow-up environmental satellite is needed. NIER surveyed a wide range of both national and international satellite data users. From this, NIER was able to derive payload specifications necessary for a new environmental satellite. In addition to the existing ultraviolet wavelength range, additional visible light region observation and higher resolution were deemed desirable. As a result, the follow-up environmental satellite payload is considering hyperspectral optics capable of observing the 300–780 wavelength range with a spatial resolution of about 2 km. If resolution improves and visible light region observation becomes possible, the accuracy of the measurements of existing major products such as ozone and aerosol will improve. Furthermore, it will be possible to produce new outputs, such as data on water vapour and night illumination. In addition, the higher spatial resolution could improve the effectiveness of pollutant reduction policies. This is because it will be possible to identify the concentration of air pollutants at the district level, and to monitor the emissions of specific industrial complexes. It is expected that policy support will be available in various fields.

09:30 [V-3-3]

Toward GOCI-III Improvement from the Experiences of GOCI-II

Jae-Hyun Ahn[1], Kyeong-Sang Lee[1], Sun Ju Lee[1], Jong-Kuk Choi[1], Eunna Jang[1], Myung-Sook Park[1], Jeong-Eon Moon[1], Tai-Hyun Han[1], Hee-Jeong Han[1], Joo-Hyung Ryu[1], Geumsil Kang[2], Ki-Beom Ahn[3], Wonkook Kim[4]

[1]*Korea Institute of Ocean Science and Technology*
[2]*Korea Aerospace Research Institute*
[3]*Sirius-K*
[4]*Pusan National University*

In this study, we discuss the development direction and requirements for the 3rd Geostationary Ocean Color Imager (GOCI-III) based on experiences with the previous GOCI (June 2010 to March 2021) and GOCI-II (March 2020 to now). The GOCI and GOCI-II are the world's first geostationary ocean color mission series, then were able to observe diurnal variations of the ocean environment for the first time. Since the development of the GOCI-II, the ocean color remote sensing community has significantly improved the algorithms and observation technics. Therefore, the development direction for GOCI-III also needs to consider the application of next-generation ocean color remote sensing approaches. In particular, the addition of polarization bands can enhance the accuracy of ocean-color products when absorbing aerosols occurs, which has been regarded as the most challenging issue in ocean-color remote sensing. Furthermore, the addition of spectral bands, adjustments to the central wavelength, and the bandwidth, in comparison to GOCI-II, could lead to overall improvements in observation capabilities and expansion of environmental information. While this study proposes the specification for GOCI-III aims to lead best performance and usability, the final specifications can be modified during the development progress by considering practical design restrictions and cost.

09:45 [V-3-4]

R&D and Development Roadmap for Optical Payloads

Sung-Joon Park[1], Gm-Sil Kang[2], Dai Ho Ko[2], Young-Jin Kim[3], Taejung Kim[4], Hagyong Kihm[5], Sehyun Seong[6], Kwangsun Ryu[7], Byung-Geun Lee[8], Hanlim Lee[9], Hyun-Jin Lee[10], Sun Do Lim[5], Seonghwan Choi[1], Jinsuk Hong[11]

[1]*Korea Astronomy and Space Science Institute*
[2]*Korea Aerospace Research Institute*
[3]*Korea Advanced Institute of Science and Technology*
[4]*Inha University*
[5]*Korea Research Institute of Standards and Science*
[6]*TelePIX Co., Ltd.*
[7]*Satellite Technology Research Center, KAIST*
[8]*Gwangju Institute of Science and Technology*
[9]*Pukyong National University*
[10]*i3system, Inc*
[11]*Hanwha Systems*

The Korea Aerospace Research Institute (KARI) is currently establishing a basic plan for the follow-up mission of GEO-KOMPSAT-2B, which was successfully launched in February 2020 and will be operated until 2030. In line with the next GEO-KOMPSAT mission and the new space R&D policy established by Korean Government, there is a need to present a new for optical payloads that reflects the updated visions and goals for launch vehicles, planetary and deep space explorations, remote sensing, and other space missions. We thoroughly reviewed the technology elements of GEO-KOMPSAT-2B and

other related missions in the past, and classified core technologies that could have a significant impact on future missions. These core technologies can be majorly considered as targets for localization for the future missions. In this paper, we present core technologies to be localized, as well as development directions and roadmap.

포스터발표 논문 초록

발표시간 : 4월 27일(목)
15:50~18:00

[P-1] KPLO Flight Software Assessment during Launch Early Operation Phase

Soo-Yeon Kang, Sun-Wook Kim
Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) LEOP activities have been conducted from August 5, 2022 to January 31, 2023 about six months. LEOP consists of 5 stages, which are Early Cruise, Trans-Lunar Cruise, Late Cruise, Lunar Orbit Acquisition (LOA) and Commissioning.This paper describes the assessment analysis and results of flight software functions at each stage during KPLO LEOP period. The assessment items of KPLO Flight software in each stage are the same. Through the evaluation results of the flight software functions during LEOP, KPLO flight software has been successfully verified on orbit.

[P-2] Determination of Command Parameters for Payload Operation of NEONSAT

Chiho Kang, Dong-Oh Kim, Daehoon Yoo
Korea Aerospace Research Institute

A user who needs image data acquired by the Earth observation satellite can submit the order for image products containing the area of interest on the Earth. In order to provide high-quality image products to users within a given time, the operation plans for payload of the Earth observation satellite should be prepared on ground in advance so that the an area of interest can be observed with the best condition in the viewpoint of both quality and timeliness. This paper describes the procedure for determining the command parameters for the operation of the high-resolution optical payload of NEONSAT, which are calculated and determined on ground during the mission operation phase of NEONSAT.

[P-3] Research on Quantum Communication Systems Applicable to Satellite

Myung-Gil Kim, Kang Toi Yoon, Je Guen Lee
SpaceK Inc

The rapidly evolving field of communication technology has seen various changes in satellite communication technology, with quantum communication being a key area of focus. Quantum communication is being developed in tandem with advancements in quantum computing, and quantum communication systems offer high levels of security, allowing for the transmission of encrypted data, and thus creating a new paradigm in communication.
The theoretical concept of quantum communication was proposed in the 1930s, but it took several decades for experimental evidence to be obtained, with Bell's inequality being published in 1964 to allow for experimental verification of quantum mechanics. The development of Quantum Key Distribution (QKD) technology in the 1970s led to its implementation in the 1980s, and in the 1990s, QKD technology was commercialized. Since the 2000s, quantum security communication technology has continued to advance, with quantum encryption, quantum authentication, and other fields seeing the application of quantum communication technology.
In 2016, China launched a quantum communication satellite, the Micius, which demonstrated the feasibility of safe and long-distance quantum communication without ground-based infrastructure, and this development has shown the importance of quantum communication technology in the field of cryptography.
This research aims to explore the components of quantum communication and to conduct a preliminary study on the potential applications of quantum communication in satellite technology, in order to provide direction for future space products utilizing quantum communication.

[P-4] Introduction to the Operation Methods of Electrical Ground Support Equipment for Low Orbit Satellite Power Supply

MinJun Kim, Hyunguk Kim, Dong-Chul Chae, Yun-Goo Huh
Korea Aerospace Research Institute

Before launching a low orbit satellite into space, it is crucial to conduct sufficient functional testing on the ground. Power supply to the satellite is essential for conducting satellite function testing. This paper provides a brief introduction to various methods of supplying power to the satellite. It will introduce the electrical ground support equipment used to supply power to the satellite, and explain how and when the electrical ground support equipment is used.

[P-5] Development of an Auxiliary Processing Program for the Automation of Manual Standard Image Processing

SongRan Kim, JunWon Lee, Junyoung Song, Min-A Kim, Guhyeok Kim, MyeongShin Lee
Korea Aerospace Research Institute

When manually processing standard image processing, the

operation is performed by the worker confirming the order and entering the corresponding order information into the processing system. In this study, a program was developed that can automatically perform the process of creating work instructions necessary for standard image processing. This program detects real-time order information for standard image processing and begins creating work order. It retrieves the raw images used for image processing and writes the setting values based on the order information. In addition, a user interface was provided to enable the monitoring of the current progress of the work process, the processing waiting list, and error list. Through this program, automation and real-time processing of standard image processing are possible, enabling more efficient operation.

[P-6] Technical Considerations on the Test of Focal Point Unit Using Fiber Optic Communication

Young-Yun Kim, Young-Sun Kim, Jong-Pil Gong

Korea Aerospace Research Institute

As the resolution of Earth observation satellites increase, accurate an fast transmission of large capacity acquired data is required, and high-speed large-capacity data transmission using conventional coaxial has difficulty in developing due to data transmission errors due to impedance mismatch between different units. In order to meet this demand, a technique using optical fibers instead of existing coaxial lines is applied. This paper discusses the basic design of test configuration for focal plane unit using optical fiber, the considerations in the development stage, and methods to identify and prevent problems that may occur in the post-development test process in advance.

[P-7] Comparative Analysis of Performance Characteristics of Different Coarse Sun Sensors for Low Earth Orbit Satellite

Yong-Bok Kim

Korea Aerospace Research Institute

The Coarse Sun Sensor Assembly (CSSA) is one of the essential sensors for the attitude control of Low earth orbit satellite. It is used to measure the direction of the sun's rays to the satellite and to determine whether the satellite is in the eclipse where it cannot see the sun. In this paper, we will be comparing and analyzing the performance characteristics of two different low-precision sun sensors that were utilized in the development of low-earth orbit satellites. We will base our analysis on ground test data that was obtained by rotating the coarse sun sensors both vertically and horizontally.

[P-8] Introduction of Practical Test Configuration through Integrated Control of Electrical Ground Support Equipment in Low-Orbit Satellites

Jin-Hyuck Kim, Jin-Ho Lee

Korea Aerospace Research Institute

In the satellite level, various electrical ground support equipment is used for verification tests. As much as possible, electric ground support equipment (EGSE) is integrated and controlled, but some electric ground support equipment is not integrated. EGSEs such as control communication and power supply perform integrated control, but image communication EGSE adopts a method of independent control. However, in recent years, image communication EGSE also needs integrated control. In addition, additional features for more efficient integrated control are needed.
In this paper, we introduce a wider range of integrated control models and features.

[P-9] Analytical Thermal Path for Improved Design of Spacecraft Radiator

Hui-Kyung Kim[1,2], Choon-Woo Lee[1]

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

The internal heat of spacecraft should be dissipated into outside. Radiators mounted on the surface are a major thermal control method to dissipate heat by radiation. The radiator would do its thermal performance fully when facing the outer space without obstructing by surroundings. There is not, however, enough affordable design space for required radiators. The additional structure of a reflector could play a role by changing the thermal path of dissipating heat through the radiator to avoid surround objects. The thermal path depends the geometric configuration of the reflector surface profile, which determine the direction of the thermal ray reflecting on the surface. There are several types of plane, parabolic shaped surface, and modified or combined profile surfaces. The thermal ray starting from the radiator could be directed into the deep space after reflecting. The single parabolic reflector gives a perfectly reflecting path into the outer space. This research focused on the analytical thermal path on the radiator with a dual, combined shaped reflector, and the effectiveness of the reflector-radiator structure.

[P-10] S-Band Communication Link Consideration for Early Operation of Low Earth Orbit Satellite

Kyun-Sang Park

Korea Aerospace Research Institute

For the early operation of the low earth orbit satellite, the

s-band communication link is inevitable to check SOH (State-of-Health) and activate the unit of the satellite. In the early operation phase, the operation mode of the satellite is in the safe-hold mode, because it is important to maintain thermally and electrically safe sate of the satellite. Thus, under the sufficient condition for the communication link margin analysis, it is possible to occur the loss of the communication link according to the null region of s-band antenna related with the satellite attitude and the attitude control accuracy. In this paper, the worst case analysis is conducted for the time duration calculation of the s-band link loss during the communication with the ground station.

[P-11] GEO-KOMPSAT Bus Operation Evolution

Keun Joo Park, Hyoung Yoll Jun
Korea Aerospace Research Institute

New geosynchronous earth orbit Korea Multi-Purpose Satellite (KOMPSAT) bus is under development by Korea Aerospace Research Institute. It heirs the predecessor, GEO-KOMPSAT-2 bus, however it is required to accommodate several key requirements. Firstly, two solar array wings are equipped and the deployment configuration during transfer orbit is different. Then, onboard fault management design is reinforced due to high mission availability requirement of communication payloads. Also, automatic north and south station keeping management using GNSS receiver measurements and electric propulsion system is newly added. In this paper, the evolution in the satellite bus operation is described.

[P-12] Analysis of Electrical Propulsion Thruster Combinations for GEO-KOMPSAT-3

Bong-Kyu Park, Hyoung Yoll Jun, Keun Joo Park
Korea Aerospace Research Institute

Abstract: This paper focuses on the electrical propulsion (EP) thrusters for GEO-KOMPSAT-3, a geostationary satellite currently under development with the aim of launching in 2027. The satellite will operate at a longitude of 128.15 degrees E and carry three different types of payloads. To perform North/South station-keeping, six EP thrusters will be used, with three on the north panel and another three on the south panel. Two of the three thrusters will provide north/south directional thrusts, while the remaining two serve as backups. However, the offset angles of the thrusters can cause unwanted East/West drift, making it necessary to analyze the drift effect of each thruster and combination of thrusters. Based on this analysis, this paper proposes backup combinations of EP thrusters that can be employed in case of any thruster failure.

[P-13] On-Ground Maintenance of the P-S Configured Flight Model Battery with Inherent BMS Circuitry

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

For a flight model battery, proper on-ground maintenance activities should be performed based on the manufacturer's recommendation during ground storage and various satellite level tests to provide the best performance during satellite in-orbit mission operation. Even during storage period when a battery is not used, regular cell voltages check is required to monitor an excessive cell voltage drop due to self-discharge and cell voltage spread between cells. When the cell spread exceeds manufacturer's criteria, forced cell balancing should be performed. And, after long term storage over 1-year of a battery, end-of-storage control activity is also required to verify battery capacity degradation and to check battery health status. Additionally, interfaces for all these on-ground maintenance are also not the same and needed to be considered depending on the battery status, stand-alone or satellite panel mounted configuration. In this paper, various on-ground maintenance methods of P-S configured flight model battery with inherent BMS circuitry are summarized and presented.

[P-14] Technoloty Trend of Passive Deorbit System

Eungsik Park, Jonghwi Choi, Keun-Woong Shin
Korea Aerospace Research Institute

Recently, the development and launch of microsatellites is increasing. However, launch costs are decreasing due to reusable launch vehicles and satellite launches. In particular, the number of satellites is increasing exponentially due to communication services and observation satellites using small cluster satellites. As a result, space debris is increasing exponentially. In addition, satellite operators sometimes miss the timing of satellite disposal by maximizing operation at the end of the lifespan of a satellite in order to pursue maximum profits. In order to escape from the threat of space debris, technologies such as launching cleaning satellites or dropping satellites on their own are being applied. In this paper, we will analyze the overseas trends of various passive deorbit systems and review the possibility of domestic satellite application in the future.

[P-15] Electric Propulsion System Configuration for a Public Multi-Purpose Communication Satellite

Jong Seok Park, Jung Su Choi, Keun Joo Park, Hyoung Yoll Jun

GEO-KOMPSAT-3 Program Office, KARI

A geostationary public multi-purpose communication satellite incorporating an electric propulsion subsystem, GEO-KOMPSAT -3, is under development. The disturbance torque generated by electric thrusters has always been one of the biggest challenges for satellite attitude control systems. There are various ways to reduce this disturbance torque through satellite design, and the thruster steering mechanism is a typical example. However, in order to avoid the design and operational concept complexity associated with the use of such a device, it was decided not to apply it on this satellite.
The main source of disturbance torque is the variation of satellite center of mass due to its propellant consumption during the lifetime, and since the direction of electric thruster orientation is fixed, disturbance torque is inevitable due to the misalignment of the satellite center of mass with the electric thruster orientation.
This paper presents a trade-off study on the electric propulsion system configuration of the GEO-KOMPSAT-3 to minimize the disturbance torque.

[P-16] Orbit Operation Result of CAS500-1

Jong-Oh Park

Korea Aerospace Research Institute

The CAS500-1 is a 500kg-class satellite for national territory management, agriculture and forestry management, disaster monitoring & control, Korean peninsula observation etc.
After CAS500-1 satellite was launched by Soyuz launcher on March 22, 2021, the performance validation and image calibration were performed almost 6 months after launch.
In this paper, I will introduce the orbit operation results of CAS500-1 Satellite during 2 years after launch.

[P-17] Necessity of Establishment an Automation System in Manual Standard Image Processing

Junyoung Song, SongRan Kim, JunWon Lee,
Min-A Kim, Guhyeok Kim, MyeongShin Lee

Korea Aerospace Research Institute

In this study, the standard image processing automation system of satellite was analyzed, and based on this, the development direction to the standard image processing automation system from the manual standard image processing was presented. Standard image processing of satellites operated by Korea Aerospace Research Institute automatically generates standard images through raw images by inputting a work order containing information on ordered images and processing options into PMS (Product Management System). However, in some satellites, standard images are still processed manually. Considering the satellites to be added in the future, the establishment of an automation system for manual standard image processing is essential to increase the efficiency of satellite operation in terms of manpower utilization.

[P-18] Generating Code Property Graphs by Analyzing Source Code with Static Analysis

Hyun-Kyu Shin

Korea Aerospace Research Institute

Static analysis of software is a technique that identifies issues in software without actually executing the program, by utilizing various properties of the source code that constitutes the software. Static analysis is used in the development process of satellite flight software, particularly to check for the existence of errors that may occur at runtime, using mathematical methods. Utilizing properties of the source code for static analysis can be used not only for issue detection, but also for designing and verifying the functionality of the software. Additionally, it can be used to manage software requirements and track change history in similar projects that share a common code base. To achieve this, the process of extracting multiple properties from the source code is required. This paper introduces how to generate code property graphs by analyzing the source code.

[P-19] An Effective 1553B Scheduling Method through GR1553B

Seung-Eun Yang

Korea Aerospace Research Institute

LEON4FT (GR740) is fault tolerant multiple core processor that is widely used to spacecraft. It contains GR1553B IP core that can be functional of BC (BUS Controller), RT (Remote Terminal) or BM (BUS Monitor). 16-byte array of transfer descriptor block is applied to construct 1553B transaction. It also provides various options to schedule 1553B transaction. “slot time” filed in the descriptor word is used to set inter-message gap time. If the previous transaction is finished sooner than the set slot time, the GR1553B core pause the current transaction until the slot time expires to zero. Transaction schedule is also configurable through combined transaction of synchronous message and asynchronous message. The priority of asynchronous message is lower than synchronous one. Therefore, asynchronous message is inserted to the transaction when enough GAP time exist between synchronous message or all synchronous transaction is finished. In this paper, various 1553B scheduling method is described for effective communication. Also, time measured result of each transaction is stated through GR1553B.

[P-20] The National Research and Development Innovation Act from the Perspective of a Research Field

Jimo Yang, KeunWoong Shin, JongHwi Choi, EungSik Park

Korea Aerospace Research Institute

The National Research and Development Innovation Act is a law that was enacted in South Korea on January 25, 2019 to support and promote the country's research and development and innovation activities. The purpose of this law is to establish and promote national research and development and innovation strategies, allocate and operate budgets for research and development and innovation, and foster research and development personnel. This law provides various systems and infrastructure to maximize the country's research and development and innovation outcomes by involving various stakeholders. The National Research and Development Innovation Act can be divided into two main categories from the perspective of researchers. Firstly, the provisions supported by this law are considered very important in terms of institutional support. Secondly, there is still a need for improvement in the implementation of this law. In the research field, we aim to examine the institutional support provided by the National Research and Development Innovation Act and discuss measures to improve and supplement the implementation of this law.

[P-21] Gravity Impact Analysis of Large Aperture Hexagonal Segment Mirror for Space Telescope

Jeoung-Heum Yeon, Jongguk Choe, Won-Beom Lee, Su-Young Chang

Korea Aerospace Research Institute

Deployable segment mirrors are used for the ultra high resolution space telescope. It is mainly due to the limited fairing volume of launch vehicles. James Webb space telescope is one such type of telescope and similar type of telescopes are under studying and development. Circular or square mirror can be used for the segment mirror. However, hexagonal mirror is properly used for the segment mirror to reduce the gap between mirrors. Light-weighting is essential for the space mirrors and the estimation of the gravity impact is necessary for the ground alignment of the telescope under gravity condition. Even for the high specific stiffness material is used for the mirror, gravity impact increases rapidly as the size of the mirror increases. In this study, the gravity impact analyses are performed for the large aperture hexagonal segment mirror. Mirror deformation and corresponding wave-front errors are analyzed for gravity conditions.

[P-22] Data-Driven Power Generation and Consumption Estimation Model Analysis for Low Earth Orbit Satellites

SeokTeak Yun, Day-Young Kim, Sang-Kon Lee

Korea Aerospace Research Institute

Low Earth orbit satellites play a crucial role in modern society, providing essential services such as communication, navigation, and Earth observation. As the number of satellites in orbit grows, understanding their power generation and consumption becomes increasingly important. This research proposes a data-driven approach to estimate low Earth orbit satellites' power generation and consumption. The proposed approach uses machine learning algorithms to analyze data and predict power generation and consumption. To estimate power generation, the model considers various factors, such as solar panel efficiency, battery capacity, and satellite orientation. Similarly, the model finds payload operations, communication activities, and onboard systems to estimate power consumption. The results of the proposed approach can be used to optimize the design of future satellites, develop better fault management strategies, and ensure optimal mission performance. The study also highlights the potential of using machine learning algorithms for other space applications, such as predicting the health and performance of spacecraft subsystems. Overall, the proposed data-driven approach offers a valuable tool for analyzing and understanding low Earth orbit satellites' power generation and consumption.

[P-23] Telemetry Monitoring and Contingency System for Low Earth Orbit Satellite

Young-Su Youn[1], Jae-Nam Yu[2]

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

The telemetry monitoring and contingency system for hardline telemetry of launch support equipment is integrated with the system testing equipment of low earth orbit satellite and is used up until the lift-off. The telemetry monitoring and contingency system automatically tracks the expected values of the satellite telemetry, which are organized in a table according to each stage, until the lift-off of the launch vehicle, and has the capability to prompt respond to any errors that occur. During the execution of the satellite telemetry monitoring table, which is prepared for each stafge according to the operation of the satellite in accordance with the launch procedure, an alert window is immediately displayed if the telemetry status or range does not match. Furthermore, in order to achieve rapid error recovery, it is possible to select a control command transmission for the corresponding telemetry wriitten in the satellite monitoring telemetry table, and if transmission is selected, it can be sent immediately to the satellite.

[P-24] Analysis of Radiated Emission EMC Test Results for Satellite System

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

Korea Aerospace Research Institute

The satellite system consist of various electrical units. Electrical component operate organically and form an electromagnetic environment. Securing EMC safety margin is essential for the proper operation of satellite under a formed environment. This paper mainly deals with radiated emission. In the case of the notch band, it is related to the sensitivity of GPS and S-band receivers. At first, it is necessary to check whether the frequency of noise measured at the system level matches the reception band, and if so, it is necessary to analyze the distance, angle to the noise source, and E-field strength. For non-notch bands, margin analysis using system-level radiated emission measurement results and susceptibility test specifications is required. To do this, it is necessary to compare the results of the unit-level radiated emission test with the results of the system level results. Accordingly, it is possible to infer a satellite shielding effect consisting of a panel and an multi layer insulation.

[P-25] Assessing the Demand for Frequency Resources to Acquire and Maintain Geostationary Satellite Networks

Seorim Lee

Korea Aerospace Research Institute

Frequency resources are a fundamental component necessary for any space activity. With the recent increase in both government and commercial activities in space, the demand for frequency resources is also increasing. This increase in demand for frequency resources leads to increases in the amount and complexity of coordination activities necessary to acquire and maintain frequency resources. This paper examines the current trend in demand for frequency resources in order to provide a better understanding of the changing frequency environment and thereafter support the planning of coordination activities to acquire and maintain frequency resources for geostationary satellite programs.

[P-26] Development of IAMMAP EQM Model for CAS 500-3

Seunguk Lee[1,2], Kwangsun Ryu[2], Chang-Ho Woo[2], Jinkyu Kim[2], Wonho Cha[2], Dongkook Kim[2], Bon-ju Koo[2], Seong-og Park[2], Dooyoung Choi[1], Cheongrim Choi[1], Dae-Young Lee[1]

[1]*Chungbuk National University*

[2]*Satellite Technology Research Center, KAIST*

The Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe (IAMMAP) is a space science payload package being developed by the KAIST Institute of Satellite Research. It will be launched by the Korean Space Launch Vehicle (KSLV-III) aboard the Compact Advanced Satellite 500-3 (CAS 500-3) scheduled for launch in 2025. IAMMAP aims to correlate equatorial electro-jet (EEJ) and equatorial ionization anomalies (EIA). It consists of an Adaptive In-phase MAGnetometer (AIMAG) to measure geomagnetic perturbations caused by EEJ currents, and an Impedance probe (IP) and Langmuir probe (LP) to measure variations in plasma density caused by EIA. AIMAG is characterized by a circuit that maintains the second harmonic signal in-phase even when the temperature changes. The IP and LP measure the same physical quantity, but the LP is equipped with an IP to overcome the disadvantage that the measurement value may change depending on the size of the satellite. IP uses a monopole type antenna to measure the upper hybrid frequency of the plasma to estimate the plasma density. This requires accurate magnetic field measurements, which is why the AIMAG data must be accurate. In this study, we present the performance measurements of AIMAG and the complementary performance measurements of IP and LP.

[P-27] Establish an Interface for Low-Orbit Satellite Standard Image Processing

Jun Won Lee, SongRan Kim, Junyoung Song, Min-A Kim, Guhyeok Kim, MyeongShin Lee

Korea Aerospace Research Institute

The standard images of some low-orbit satellites, which is operated by the Korea Aerospace Research Institute, are being processed with the intervention of workers as there is no interface implemented in the Order Management System (OMS) that changes its status. To automate the low-orbit satellite standard processing system, it is essential to establish an interface in the same format as other satellites. In this study, we used FTS (File Transfer System) to distribute PGRs (Product Generate Request) generated from OMS to each LP so that they can be processed at each LP (Level Processor). Furthermore, after standard image processing, we collected the products generated at each LP to storage, and created PGS to be reflected in OMS in accordance with the existing system. Since real-time updates are possible through this interface without the need for manual intervention by workers, it is expected to effectively contribute to the operation of the standard image processing system.

[P-28] A Study on the Integrated Multi-Satelllite Download Scheduling System

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

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

The importance of not only quickly establishing a imaging plan for emergency requests such as disasters, but also stably securing images is increasing. To ensure stable image acquisition, the operator does not apply the default setting value of the receiving plan, “delete”. Instead, a receivng plan is established at several receiving stations by setting a “Image save after receiving” value. After satellite image data receiving is completed, the result of image data is checked, and in case of success, a deletion plan is established, and in case of failure, a receiving plan is established again. In order to automatically perform such an unusual type of request, it is necessary to improve the Multi-satelllite Download scheduling System.
When download scheduling, in case of an emergency request, the download plan is established by applying the retain option up to the requested number of receptions. In addition, the function of the download scheduling system will be improved so that a download plan or deletion plan can be automatically established depending so whether the image data is acquired or not. Through the improved system, it is expected that it will be possible to secure images quickly and stably by reflection the requirements of various users.

[P-29] Fundamental Research on Communicaton Protocols for Standard Space Exploration Vehicles

Hyun-Su Lim

Korea Aerospace and Research Institute

Investments for various lunar and Mars space exploration are expected to continue to grow, centering on spacecraft advanced countries. While South Korea’s space exploration has mainly focused on satellites in Earth orbit, it can be said that deep space exploration including the Moon has begun with the launch of the lunar orbiter Deneb. In the 2030s, it is planned to launch its first lunar lander, which could lead to diverse space exploration missions, including to Mars and asteroids. While developing mission-specific spacecraft for various deep space explorations is possible, considering the technology gap with other spacefaring nations, developing a standard space exploration spacecraft model could reduce development time and costs. For the mission control and payload data transmission of the standard space exploration spacecraft, communication with Earth is essential, and global space internet programs such as Lunanet and Moonlight are currently being developed by NASA and ESA. Furthermore, by analyzing the communication protocol trends for foreign space exploration spacecraft planned to be launched in the 2030s, a basic design of communication protocols suitable for the standard space exploration spacecraft will be developed.

[P-30] A Study on LUTI Images Application Method for *In-Situ* Resource Utilization

Yoon-Jeong Jang

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) is Korea's first lunar orbiter that performs scientific missions and produces space science data. The orbiter will be tasked with surveying lunar resources such as water ice, helium-3, silicon, iron oxide, rare earth elements, etc., and produce a lunar terrain map to help select future lunar landing sites. Image data of KPLO is obtained from LUnar Terrain Imager (LUTI), which is a high-resolution camera. Using the data of image, it can be used for ISRU (In-Situ Resource Utilization) space resource analysis. Through this, it is possible to identify the elements of major lunar resources through derivation of valuable resources on the lunar surface and related studies. As a result, they realize primary resources and reduce costs by minimizing the movement of resources by securing original technology for space infrastructure based on lunar terrain conditions. This study ultimately aim to research overall process of LUTI image analysis and utilization plan for space ISRU.

[P-31] An Introduction on GK3 Fault Management Preliminary Design Progress

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

Korea Aerospace Research Institute

Currently, The geostationary public multi-purpose communication satellite is the first communication satellite developed domestically in Korea. Last year, a System Design Review (SDR) was conducted and the preliminary design is currently underway. In a previous paper, the definition and design progress of activities to be performed in fault management preliminary design were introduced. Generally, Fault Detection, Isolation and Recovery (FDIR) design is performed using a top-down method that defines system fault modes from operational concepts, subsystem fault modes, and equipment fault modes based on the FMECA of units, as well as a bottom-up method that performs functional analysis of subsystems and defines the satellite fault modes. Currently, system fault mode definition has been performed through the top-down method, and redundancy status and On/OFF states of units have been defined according to the fault modes. In addition, conceptual design has been performed up to Safing based on the satellite operating scenario from launch to solar array deployment and transition orbit. On the other hand,

FMECA of some domestically produced units has been performed using the bottom-up method.

[P-32] Considerations When Using Absolute Time Command

Dong-Seok Chae

Korea Aerospace Research Institute

An ATC (Absolute Time Command) consists of a time tag and a command which is executed at that time. ATCs are stored in CSA (Command Storage Area) until the on-board time is equal to or greater (whthin an overdue limit) than the ATC time tag. There are two paths for ATCs: from the ground, or activation of a RTCS (Relative Time Command Sequence). There are a few exceptions or considerations when using ATC. Since there are cases where ATC commands cannot be executed at a correct time, and the size of the CSA that can be stored is limited, it is necessary not to exceed the size of the CSA including RTCS scheduling. This paper introduces the overall ATC processing process and some considerations that have to be considered when using ATC.

[P-33] Development and Initial Experimental Result of the AIMAG EQM for the CAS 500-3

Dooyoung Choi[1], Seunguk Lee[1,2], Kwangsun Ryu[2], Chang-Ho Woo[2], Jinkyu Kim[2], Wonho Cha[2], Dongkook Kim[2], Bon-ju Koo[2], Seong-og Park[2], Cheongrim Choi[1], Dae-Young Lee[1]

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

The Adaptive In-phase MAGnetometer (AIMAG) is a magnetometer of the Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe (IAMMAP), which is one of the scientific instruments for the Compact Advanced Satellite 500-3 (CAS 500-3). The main goal of AIMAG is to measure the Equatorial Electro-Jet (EEJ) by measuring the residual geomagnetic field. AIMAG is a ring core type fluxgate magnetometer, designed to measure the two axial components of the magnetic field in one bobbin. There are three magnetometers, one at each end of the solar panel wings and one on the satellite body. For measuring the low Earth orbit geomagnetic field, the dynamic range is designed to be ± 60,000 nT, and the measurement resolution is < 1 nT. In this study, the structure of the AIMAG Engineering Qualification Model (EQM) is presented in detail.

[P-34] Test MGSE Development for Verifying RF Interference Phenomena between Communication Antennas of Geostationary Satellite

Jung Su Choi, Jong Seok Park, Jae Dong Choi, Ju Hyun Kim

Korea Aerospace Research Institute

This study presents a test configuration and MGSE development for verifying RF interference phenomena between TMTC antenna, DCS antenna, SBAS Tx antenna, SBAS Rx antenna, and GNSS Rx antenna of GEO-KOMPSAT-3 satellite. To check for interference between communication antennas, EM (engineering model) antennas were manufactured. A mock-up table with the same shape as the top floor of the satellite was also developed. The mock-up table MGSE was designed with a minimum height to reduce the impact of reflected waves on the test facility's floor and was made of an aluminium surface identical to the satellite structure. The antennas interface brackets were designed taking into account the hole pattern, mounting height, and tilt angles of the EM antennas. In particular, a height adjustment device was added to the bottom of the GNSS Rx EM antenna. Additionally, a remote 3D position measurement was performed using a laser tracker before assembly the antennas on the mock-up table.

[P-35] An Experimental Study of the Application of EDSR-Based Super-Resolution to Geostationary Satellite Imagery

Sungsik Huh

Korea Aerospace Research Institute

Improving satellite optical systems for better spatial resolution of satellite imagery is cost-prohibitive due to physical and optical limitations. Therefore, super-resolution research is being conducted as a viable alternative way to improve spatial resolution. While much progress has been made in super-resolution of low earth orbit satellite imagery, the need for super-resolution of geostationary satellite imagery is anticipated to increase in the future.

In this paper, we applied an EDSR-based super-resolution approach to geostationary satellite imagery. First, we constructed a super-resolution training dataset using GOCI-II images from the GK-2B satellite and used it to train and fine-tune the EDSR model. Then, we tested the trained super-resolution model to enlarge the AMI image of the GK-2A by four times, and the test results were compared with those of a traditional upsampling method.

[P-36] Review of Damping Factor Application Cases for a Large Optical Satellite Micro-Vibration Analysis

Ki-Lyong Hwang[1], Myung-Suk Go[2], Han-Byeol Jeong[3], Jeong-Do Kim[1], Jae-Hyuk Lim[2]

[1]*Korea Aerospace Research Institute*
[2]*Jeonbuk National University*
[3]*Korea Aerospace Industries*

Micro-vibrtation analysis involves various factors such as finite element model, damping factor, and cutoff frequency. Here, we know that the damping factor affects the amplitude of the frequency response, and we generally apply a conservative values to micro-vibration analysis. In this paper, we applied various damping values to the large optical satellite finite element model for micro-vibration analysis, compared them with the micro-vibration test acceleration results, and reviewed the appropriateness of the damping value range.

[P-37] Development of Data Integrity Verification System for Timely Distribution of Satellite Image by Demand Organization

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

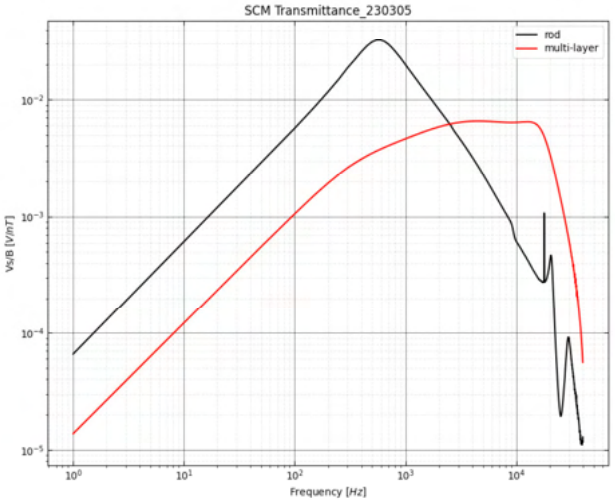
The images by the low-earth orbit satellite are transmitted to ground stations via X-band and are processed in Level0F format. The Level0F processed by the Data Ingestion System (DIS) is then processed by the Image Processing System (PMS) to generate standard images for users, including demand organization.

In the past, when demand organization requested a satellite image, the image was manually delivered through the DIS or PMS based on a request list. However, this method had the disadvantage of potential human error and difficulty in responding quickly. Therefore, the Korea Aerospace Research Institute has developed a data integrity verification system to distribute satellite images quickly and accurately. The system classifies demand requests by the order information in the image and automatically delivers the satellite images to the target of the demand organization, while also performing integrity verification at the image unit level. Through the development of this system, it is expected that human errors associated with the previous method will be reduced, and satellite images can be distributed in near real-time depending on the purpose of the demand organization.

[P-38] A Frequency Response of Multi Core Layer Search Coil Sensor

Hyeonji Kang[1], Yunho Jang[1], Seungmin Lee[2], Ho Jin[1], Khan-Hyuk Kim[1]
[1]*School of Space Research, Kyung Hee University*
[2]*Department of Astronomy and Space Science, Kyung Hee University*

In space research, the search coil magnetometer that measures



the AC component of the magnetic field up to tens of kilohertz has been used to observe electromagnetic plasma waves.

In typical search coil design, sensors consist of a large number of wire turns and a high permeability single rod. The main detection principle is Faraday's law of induction. It is that measuring a voltage depending on the rate of change of flux density is induced by Faraday's law of induction when an external magnetic field passes through the coil.

The weak output signal should be amplified through a pre-amplifier. But one of the issues of the search coil magnetometer is its own resonant frequency. It is difficult to use a single amplifier because the voltage at the resonant frequency range is much larger than the output voltages at the other frequency range. Therefore, previous research had used the feedback voltages method which can flatten the output voltage at the resonant frequency.

In this study, we introduce a new method to reduce the resonant voltages with a multi core layer (MCL) without the flux feedback coil or the equalizer.

It consists of a two-layer structure on the mechanical support core rod. At the lower layer, a rolled amorphous alloy sheet is located. Above the bobbins, the other amorphous alloy sheets are wound between the bobbins and wires. As a result, it can suppress the resonance voltages of the coil. Moreover, the sensitivity of MCL is similar to the single-rod structure. In addition, a weight of the new core structure is decreased more than 85% compared with the traditional cylindrical core.

In this paper, we introduce the performance for one of the test configurations with MCL.

[P-39] Full Well Capacity Acquisition from Detector Photon Transfer Curve in Satellite Electro-Optical Camera

Youngsun Kim, Haeng-Pal Heo
Korea Aerospace Research Institute

Full Well Capacity (FWC) is one of most important characteristics in the detector like CCD or CMOS image sensor to show amount of charge can be stored within an each pixel. Accurate sensing of FWC helps to design a front end electronics to have optimal performance. Various methods such as by evaluating the non-linearity characteristics can be applied to acquire detector FWC. Photon Transfer Curve (PTC), which is another characteristics of the detector, shows the relationship between signal and noise. The noise stochastic characteristics makes to be able to evaluate the FWC from PTC measurements. The process how to get PTC from the noise measurements is shown in beginning in the paper. Finally, the paper shows the detailed process get FWC from PTC measurements in the satellite electro optical camera.

[P-40] Introduction to X-Ray Pulsar Navigation

Hwan-Chun Myung, Sung-Soo Jang

Korea Aerospace Research Institute

Since the pulsar was first found in 1967, it has been known that they are widely distributed in the universe. Due to the periodic rotation and the raidowave emission along their magnetic axis, they are observed as a periodic signal on the Earth. As a result, many researchers have studies the pulse-based navigation for the deep space applications. In the paper, some in-orbit tests for the X-ray pulsar navigation are introduced: ARGOS (Advanced Research and Global Observations Satellite), XPNAV (X-ray Pulsar Navigation)-1, SEXTANT (Station Explorer for X-ray Timing and Navigation Technology), Insight-HXMT (Hard X-ray Modulation Telescope) satellite. In 1999, ARGOS was launched with an objective of autonomous satellite navigation. Using x-ray sources, it showed that the pulsar can be used for attitude/position determination and time-keeping. As another experimental satellite, XPNAV-1 was developed at China in 2016 in order to test the X-ray instruments, verify the ability of X-ray pulsars observation, and accumulate X-ray data. SEXTANT was an technology mission to use NICER (Neutron-star Interior Composition Explorer) installed on ISS. Its goal was to first demonstrate the in-space, autonomous, X-ray pulsar navigation. During NICER's nominal 18-month in 2017, SEXTANT performed the advanced pulsar-navigation technology. In 2017, China also adopted the new navigation method of Insight HXMT to autonomously determine the satellite orbit.

[P-41] A Study on the Implementation of Various Temperature Information Processing of the Electronic Ground Support Equipment for Satellite Payload Development

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

Korea Aerospace Research Institute

The electronic ground support equipment used for satellite payload development performs various verification and support tasks in the unit development and test phase. A payload performing many functions uses various temperature sensors suitable for each assigned role to acquire corresponding temperature information and use it for effective operation. Where sensitive temperature information needs to be acquired, a sensor that has a small acquisition temperature range but can obtain detailed information is used. Depending on the type of various sensors used, there are many methods of acquiring related information, and a method of matching an acquired electronic signal with an accurate temperature is very important. There is also temperature information directly acquired by the electronic ground support equipment, and there is also a case where the temperature obtained and transmitted by the unit is corrected and used. In order to acquire accurate information about many functions of the unit used in the ground test verification equipment, a method for obtaining various temperature information is implemented.

In this paper, the implementation method, operation, and processing method of the temperature information acquisition system implemented in the verification equipment in relation to the processing of various acquired temperature information are described for the accurate mission performance of the satellite payload.

[P-42] Reduction of Memory Defect Handling Time on Space-Born Memory Equipment

Jong-Tae Lee, Eung Shik Lee, Haeng-Pal Heo

Korea Aerospace Research Institute

Most electro-optic earth observation satellite require a memory equipment to store image data before sending that data to the ground station. In the meantime, memory device have been changed from SRAM to SDRAM, FLASH, etc. for better power consumption and volume. As sensor technology develops, the required memory capacity has also increased rapidly, and accordingly, the possibility of errors occurring in the memory itself has greatly increased. While on orbit operation, it is necessary to inspect and remove errors occurring in the memory periodically or at the time of recognition. In this paper, we propose a solution from an operational point of view to reduce the increased memory defect checking time due to the use of large capacity FLASH memory.

[P-43] Technological Trends of Life Support System in *In-Situ* Resource Utilization Technology

Joohee Lee, Younkyu Kim, Jongwon Lee, Dongyoung Rew

Korea Aerospace Research Institute

Recently, not only the foreign government sector but also private sectors are increasingly interested in the manned space technologies that can expand human activities in near-Earth space environments. Private companies are also increasingly interested in manned lunar exploration and Mars exploration. NASA and Space-X in the U.S. are also working on plans for manned Mars exploration in the 2030s. One of the key technologies of manned Mars exploration is life support system technology. In the deep space exploration, which is as far away as Mars, everything cannot be taken from Earth, so it is essential to develop a life support system technology using in-situ resource utilization (ISRU). In Korea, the manned space exploration plan has not yet been visualized after the Korean Astronaut Project in 2008, but it is necessary to continuously develop and research major core technologies for future manned space exploration plans through international cooperation. In this paper, the development trends of life support system technologies using the in-situ resource utilization will be introduced.

[P-44] Plan of the Environment Tests for the Performance Verification of the CAP-W Payload of CAS-4 Satellite

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

[1]*Korea Aerospace Research Institute*
[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.

In order to verify the performance of the CAP-W payload, a comprehensive set of in-orbit environment tests are planned, including vibration and thermal vacuum tests. The vibration test is performed to simulate the harsh conditions of a launch and assess the payload's ability to withstand the mechanical stresses that occur during the launch phase. The thermal vacuum test, on the other hand, simulates the extreme temperature and pressure conditions of space and evaluates the payload's performance under these conditions.

After the in-orbit environment tests, the consistent optical performance of the CAP-W payload is verified through the MTF measurement test in thermal vacuum conditions. The MTF test measures the capability of the payload to transfer spatial information from the object being imaged to the image captured by the sensor. It is a critical factor that determines the sharpness and clarity of the images captured by the payload. The MTF test is performed under thermal vacuum conditions to simulate the extreme temperature and pressure conditions of space and ensure that the payload's performance is consistent even under these conditions.

In this paper, we outline the plan for the environment test and describe the method of MTF (Modulation Transfer Function) measurement test in thermal vacuum conditions for the CAP-W payload of the CAS-4 satellite. This approach will help ensure that the payload performs as expected in space and will provide valuable data for further analysis and improvement of future space payloads.

[P-45] Investigating Equinoctial Asymmetry Variation in the Equatorial Ionosphere Using Ground-Based TECs in Ho Chi Minh City, Vietnam

Hoang Ngoc Huy Nguyen[1,2], Woo Kyoung Lee[1,2], Young-Sil Kwak[1,2], Byung-Kyu Choi[1]

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

Our study investigates the variation of equinoctial asymmetry in the solar cycle by examining the total electron content (TEC) derived from GPS data in Ho Chi Minh City, Vietnam (GLAT 10.52 N, GLAT 106.48 E, MLAT 1.39 N), over a period of 2018 to 2021. Our findings reveal that TECs are greater during the March equinox (ME) than the September equinox (SE) in 2018 and 2019, when solar activity is minimal, while the opposite is observed in 2020 and 2021, when solar activity is slightly stronger. These results are confirmed using both GPS data and Global Ionospheric Maps (GIMs). Interestingly, the International Reference Ionosphere-2016 model simulations consistently show greater TECs in ME than in SE. To understand the underlying cause of this shift in equinoctial asymmetry, we compare our findings with neutral composition changes and thermospheric wind variations.

[P-46] 3D Reconstruction of Solar Coronal Magnetic Fields Based on MAS by Deep Learning

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

Kyung Hee University

In this study, we use a well-known deep learning model (Pix2pixHD) for image translation to generate 3D solar coronal magnetic fields. We consider synoptic photospheric magnetic fields as input to obtain 3D solar coronal magnetic fields. 4426 pairs of inputs and outputs are considered for training, validation, and testing from 2010 June to 2020 May, which is simulated with the MHD Algorithm outside a Sphere (MAS) model. We train 54 different deep learning models to cover from 1 to 30 solar radii for the solar coronal magnetic fields.

Our main results from this study are as follows. First, our model reproduces 3D coronal field structures from 1 to 30 solar radii with an average correlation coefficient value of about 0.96. Second, during both the solar active and quiet periods, the AI-generated data are consistent with the target MAS simulation data. Third, compared to the usual MAS simulation time, the 54 deep-learning models take about 41 seconds to generate the results with an NVIDIA Titan XP GPU. As the MAS simulation is a regularization model, we may significantly reduce the simulation time by using our results together with the coronal density data produced in a similar way as an initial magnetic configuration to obtain an equilibrium condition. Furthermore, we hope that the generated solar coronal parameters can be used for near-real-time forecasting of heliospheric propagation of solar eruptions in the future.

[P-47] Search for Relation between Change in Free Core Nutation and Geomagnetic Jerks

Sung-Ho Na[1], Yu Yi[2]

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

The Earth's free core nutation is a mode of rotational perturbation of the Earth's rotational axis (dX, dY) in the celestial sphere. Geomagnetic jerks have been reported and were presumed to be related with the changes of Earth's rotation. We currently investigate the changes of amplitude and phase free core nutation as the main component in the (dX, dY) time series by using a new wavelet and attempt to find certain relation between the geomagnetic jerks and the free core nutation.

[P-48] Why should We Pay Attention to the Space Environment during Solar Minimum?

Kyung Sun Park[1], Young-Sil Kwak[2], Jinhye Park[3]

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

We carried out a high-resolution 3D MHD simulation of the interaction between the solar wind and the magnetosphere during a strong magnetic substorm on June 8, 2019, during the solar minimum. The input parameter to the simulation was from the OMNI solar wind and IMF data for 8 hour period on June 8. The solar wind density is over 20 cm^{-3} and it increases up to 49 cm^{-3} with a slow velocity. The dynamic pressure of the solar wind is in the range of 2–12 nPa. The IMF Bz has decreased to −18.5 nT at 1655 UT. In this period, there was no solar flare and CME, and zero sunspot number. However, the AL index reached the minimum value of −1,500 nT when the Dst index was not changed significantly. The cross-polar cap potential value from SuperDARN had up to 83 kV while it maintained above 60 kV. Similar disturbances phenomena were frequently observed in 2019 even though the solar minimum. We selected several similar events to identify the causes and differences. From the simulation results, we show that the configuration of the magnetic field lines is dramatically changed by the IMF angle. The stretched closed field lines appear at dawn and dusk flank regions. The strong tail reconnection occurs during the strong southward IMF at 1655 UT but the plasma sheet becomes thin after the tail reconnection and the strong tailward flow there. The flow in the throat region (near noon) is poleward on the dayside and enhanced energy flux on the dayside is confined in the cusp region. The open-closed boundary extends at 66° on the night side. The cross-polar cap potential is governed by IMF Bz in this event. The simulated cross-polar cap potential is consistent with the inferred from the SuperDARN observation.

[P-49] Source Regions of Solar Energetic Particles Examined by the Synchronic Potential Field Source Surface Model

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

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

We study the magnetic field configurations of the source regions for 6 solar energetic particle (SEP) events accelerated near or behind the limb of the Sun. For this, we use AI-generated farside magnetograms at a near real-time basis developed by Jeong et al. (2022) and AI_{HMI}-PFSS extrapolations up to $2.5R_{\odot}$, which are computed using the input of the synchronic data combining AI-generated farside magnetograms and HMI magnetograms. By comparing the AI_{HMI}, HMI, Global Oscillations Network Group (GONG), and air force data assimilative photospheric flux transport (ADAPT) synoptic magnetograms as well as the four different PFSS extrapolations from the magnetograms, we find several interesting differences between them, in view of SEP source region and magnetic field configuration. 1) The structures and sizes of the source active regions (ARs) are significantly changed. The total unsigned magnetic field fluxes of the source ARs are mostly stronger in the AI_{HMI} magnetograms than in the HMI and GONG magnetograms, except for one event. For two out of the 6 events, the total fluxes in the AI_{HMI} magnetograms are larger than the ADAPT magnetograms. 2) In particular, newly emerging ARs are observed near the SEP source regions in the AI_{HMI} magnetograms for two cases. The locations of the emission features in the full-sun EUV synchronic maps are consistent with the ARs generated in the AI_{HMI} magnetograms. 3) The overall polarity inversion lines are changed due to the changed strengths of the ARs, the appearance, and the

disappearance of the ARs. For two events having significant changes in the neutral lines near the source regions, the propagation directions of the eruptions in the running difference EUV images are comparable to the configurations of the inversion lines in the AI_{HMI} extrapolations.

[P-50] 3-Day Forecasting of Solar Wind Speed Using SDO/AIA 211 and 193 Å Images by a Deep Learning Model

Jihyeon Son[1], Suk-Kyung Sung[2], Yong-Jae Moon[1,2], Harim Lee[2], Hyun-Jin Jeong[2]

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

In this study, we forecast solar wind speed for the next 3 days with 6 hours cadence using a deep learning model. For this we use SDO/AIA 211 and 193 Å images together with solar wind speeds for the last five days as input data. Total period of the data is from 2010 May to 2020 December. We divide them into training set (January-August), validation set (September), and test set (October-December) to consider the solar cycle effect. The deep learning model consists of two networks: a convolutional layer based network for images and a dense layer based network for solar wind speeds. Our main results are as follows. First, our model successfully predicts the solar wind speed for the next 3 days. Root mean square error (RMSE) of our model is from 37.4 km/s (for 6 h prediction) to 68.2 km/s (for 72 h prediction), and correlation coefficient (CC) is from 0.92 to 0.67. These results are much better than those of the previous studies. Second, the model can predict sudden increase of solar wind speeds caused by large equatorial coronal holes. Third, solar wind speeds predicted by our model are more consistent with observations than those by the WSA-ENLIL model, especially in high speed stream regions. It is also noted that our model cannot predict solar wind speed enhancement by CMEs. Our study demonstrates the effectiveness of deep learning for solar wind speed prediction, with potential applications in space weather forecasting.

[P-51] Observation of the Vertical Reversal of D/E-Region Eastward Flow to Westward Convection Flow in Dusk Sector

Young-Sook Lee[1], Young-Sil Kwak[2,3], Yong Ha Kim[1], Ram Singh[1]

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

This study reports an interesting feature of D/E-region eastward flow observed in the dusk sector (16–18 MLT). The D/E-region eastward flow opposes the coexisting westward E × B convective flow in the upper layer of E/F ionospheric regions. The events are mostly accompanied with sunward ion drift flow (westward convection) measured at 800 km altitude by DMSP satellite. Therefore, The D/E-eastward flow channel appears abruptly as a reversal to the upper (E/F) region extending from the magnetosphere. The feature is distinguished from abnormal subauroral ion drift (ASAID). ASAID is eastward flow channel with R1 field-aligned current increase, accompanied with anti-sunward ion drift flow (eastward convection) by DMSP/SSIES. As summer approaches, the observed eastward flow increases in the altitudinal width (D/E region). In this presentation, we discuss about the characteristics and causes whether by the arrival of westward traveling surge, local electric field or effects of altitudinal composition.

[P-52] Nonequilibrium Processes in the Solar Corona

Jin-Yi Lee

Kyung Hee University

The solar corona is optically thin and composed of hot and low density plasma. The observed solar corona analysis often assumes both ionization equilibrium and Maxwellian electron velocity distribution. I introduce the nonequilibrium processes of both the nonequilibrium ionization and non-Maxwellian electron velocity distributions in solar corona plasma, such as flare, coronal mass ejections, and solar wind. In the analysis considering nonequilibrium, the ion compositions are calculated using a time-dependent ionization model with various kappa distributions, representing high-energy tails deviating from a Maxwellian velocity distribution (i.e. thermal) and decreasing as a power law. The ion charge states will ultimately freeze-in, even though the solar plasma continues to expand and cool as it propagates. I introduce what the calculated ion compositions with various kappa distributions tell us by comparing the observations in the corona and situ.

[P-53] Proton Temperature Anisotropy Affected by Alfven Wave Turbulence and Micro-Instabilities in a Slow Solar Wind

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

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

We present a one-dimensional model for the slow solar wind that takes into account the effects of a curved magnetic field and low-frequency Alfven-wave turbulence, including the dissipation of anisotropic turbulent cascade for heating and acceleration. We extend the mechanism previously proposed for

the fast solar wind to apply to the slow solar wind, incorporating the effects of micro-instabilities on proton temperature anisotropy. Our model produces a solution for the slow solar wind and suggests that the fast and slow solar winds may share a common heating mechanism. The numerical solution also shows that the proton cyclotron instability is an important physical process responsible for regulating proton temperature anisotropy at around 10–30 solar radii and Earth.

[P-54] Study of Solar Preflare Activity in Microwave Observation

Hongdal Jun[1,2], Sujin Kim[1]

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

The goal of this study is to investigate the relationship and characteristics of solar preflare and main flare in microwave. For this study, first of all, we collected M and X-class flares listed on GOES X-ray flare list (https://hesperia.gsfc.nasa.gov/goes/goes_event_listings/) from 2008 to 2016 (766 events), and examined the microwave flux curves of the collected flares obtained by Nobeyama Radio Polarimeters (NoRP) at 17 GHz (162 events). Then, among of them, we selected 12 flares which has a preflare enhancement in the microwave flux profile within 20 minutes before the main flare start time. For the selected flares, we have investigated preflare characteristics using microwave imaging data obtained at 17 and 34 GHz of Nobeyama Radioheliograph (NoRH) and in addition, we have examined EUV images and magnetograms obtained by Atmospheric Image Assembly (AIA) and Helioseismic and Magnetic Imager (HMI) onboard Solar Dynamics Observatory. In the presentation, we introduce preliminary results of this study.

[P-55] Mission Concept Study of Rover System for Lunar *In-Situ* Resource Utilization

Younkyu Kim, Dong Young Rew, Joohee Lee

Korea Aerospace Research Institute

The Artemis program for sustainable lunar surface exploration is recently being carried out utilizing lunar *in-situ* resources. Accordingly, the lunar surface exploration rover mission and payloads are also under development for exploration and analysis of water, resources, and volatile materials in relation to ISRU in the lunar polar region from lunar surface movement and topography missions before, and in the future, the resource mining and utilization mission will be performed for sustainable lunar surface exploration and manned habitation on moon. In this study, the ISRU-related mission concept and strategy studies for the lunar surface exploration rover are carried out. The second phase of the domestic lunar exploration project (moon lander) will be equipped with a small-scale rover, and after the small-scale (several tens of kg) rover mission, it is necessary to develop a mission that can contribute internationally corresponding to medium-sized Rover that meets the level of ISRU and Artemis programs. For example, from a mission to explore the topography of the moon's surface with various spectrometers and drilling around 10 cm in a lunar surface exploration mission, a mission to explore resources by mounting an all-in-one drilling equipment for subsurface sampling, sample processing, and sample analysis may be required. Once these resource exploration/analysis missions are completed, rovers capable of collecting, transferring, and providing regolith and extracting resources through them will be carried out in relation to ISRU. In the future, ECLSS, which enables long-term missions of manned spacecraft and a core system of manned exploration rovers, is required for manned rover which is provided with resources extracted through ISRU. This study carries out a mission concept study of unmanned rovers and manned rovers for lunar surface exploration and suggests the required rover system and payload levels for the mission.

[P-56] Science Data Management Subsystem Operation during the Danuri LEOP

Joo Hyeon Kim

Korea Aerospace Research Institute

On August 5, 2022, the Korean first lunar orbiter, Danuri (KPLO), was launched and operated during the Launch and Early Orbit Phase (LEOP) until February 3, 2023. Since then, Danuri has been operating scientific and technology demonstration missions in the lunar orbit at an altitude of approximately 100 km, which marks the nominal mission phase. The Danuri carries six mission payloads, including five scientific instruments and one technology demonstration instrument. Three of the science mission instruments are developed by Korean domestic research organizations and university.
The scientific data observed by the Korean domestic instruments is being provided to the science mission operation centers via the KPDS (KARI Planetary Data System) of the SDMS (Science Data Management Data Subsystem). The processed data will also be released to the public for scientific research and education. In this paper, we present the process and results of the SDMS operation during the Danuri LEOP.

[P-57] Science Instruments for Lunar Surface through KASI's DALO Initiative and NASA's Artemis/CLPS Program

Chae Kyung Sim[1], Young-Jun Choi[1], Dukhang Lee[1], Seul-Min Baek[1], Jehyuck Shin[1], Jongho Seon[2], Sungsoo S. Kim[2], Minsup Jeong[1], Ho Jin[2], Sung-Joon Ye[3]

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

The Korea Astronomy and Space Science Institute (KASI) is conducting lunar science and exploration research under the Discovery Across Lunar Observations (DALO) initiative which aims to understand the lunar environment not only from a scientific perspective but also in terms of future human-related experiments. To advance our comprehension of the lunar surface via in situ scientific measurements, KASI is developing payloads to operate on the lunar surface using NASA's Commercial Lunar Payload Services (CLPS) initiative, a part of Artemis program, based on the KASI-NASA Exploration Working Group. The Ministry of Science and ICT (MSIT) is sponsoring the development, mission operation, and data analysis phases of the selected payloads.

The four payloads, LUSEM, GrainCams, LVRAD, and LSMAG, were chosen based on their scientific merit and expected technical readiness. LUSEM has two pairs of solid-state telescopes (SST) to detect high-energy particles in the tens of keV to tens of MeV range. It will be onboard the Nova-C lander of Intuitive Machines (IM) which will be operated on the Reiner Gamma swirl on the Moon in 2024. GrainCams consists of two cameras designed to investigate the microstructure of highly porous upper regolith and the dust particles lofted in the vicinity of the surface. LVRAD is a suite of radiation detectors designed to quantify the radiation environment on the lunar surface and assess its potential impacts on biology in preparation for future human-related activities on the Moon. LSMAG will measure the magnetic field on the lunar surface in situ, using two fluxgate magnetometers and an accelerometer including a three-axis AMR sensor.

The results of this research initiative will provide valuable knowledge, technology, and experience that will be advantageous to future space exploration missions.

[P-58] The Noise Calibration Study of KMAG: To Eliminate the Spacecraft-Generated Disturbances

Junhyun Lee, Ho Jin, Khan-Hyuk Kim, Hyeonhu Park, Wooin Jo, Yunho Jang, Hyeonji Kang

School of Space Research, Kyung Hee University

The KPLO-MAGnetometer (KMAG) is installed with three tri-axial fluxgate sensors (KMAG1, 2, & 3) inside the 1.2-meter boom onboard the Danuri to measure the magnetic field around the near-lunar environment in situ. The deployment of the KMAG boom was successfully performed 4 hours after launch, and then each KMAG sensor immediately started to measure the magnetic field. All of the KMAG sensors have measured the magnetic field in each space for the whole period of cruising the ballistic lunar transfer orbit until reaching the lunar orbit. The KMAG team confirms that the KMAG data shows a similar variation to other time-shifted magnetic field data from DSCOVR and THEMIS satellites, but the discrepancy in the magnitude of the magnetic field for each direction is also shown. This discrepancy is generally caused by the sensor's offset and the influence of the spacecraft-generated magnetic field. In this study, we focus on the correction for the initial measurement of the KMAG related to the spacecraft maneuver. The types of these variations show a point of similarity in which the measured magnetic field is suddenly and dramatically varied for all tri-axial directions. Therefore, the non-natural magnetic field, compared to the ambient magnetic field, can be considered as an independent signal with a broad variance. The spacecraft-disturbed magnetic field signal can be extracted using the blind source separation technique. In addition, by comparing measurements from sensors placed at different distances, the magnitude of the disturbance of the magnetic field can be corrected by the reduction technique for the single disturber in the maximum variance direction. In this paper, we present the initially corrected results of the KMAG measurement, which take into account the spacecraft-generated magnetic field.

[P-59] Initial Operation of Ancillary Data Generator Module and Initial Operational SPICE Kernels for KPLO

Jo Ryeong Yim, Dong-Gyu Kim

Korea Aerospace Research Institute

KPLO (Korea Pathfinder Lunar Orbiter) is the first Korea's space exploration satellite for the Moon developed by Korea Aerospace Research Institute. It was successfully launched on August 5th in 2022 and entered its lunar orbit for normal mission on December 26th in 2022 after long journey to the Moon for more than four and half months. KPLO accommodates five science payloads including optical payloads, LUTI (Lunar Terrain Imager) and SHC (ShadowCam). For science data processing, it needs information such as satellites's state of health, orbit ephemeris, attitude, on-borad time information and so on so called Ancillary Data. KPLO mission operation center provides the ancillary data of KPLO in a standard ancillary data format, SPICE kernels, built by NAIF (The Navigation and Ancillary Information Facility). ADG (Ancillary Data Generator) module is a functional modules in Mission Planning Subsystem, which is responsible for producing the kernels. During the transfer phase from launch to the lunar orbit, the module was initially and daily operated and tested with the real operational data. KPLO have been producing huge amounts of science data, state of health data and SPICE kernels since KPLO entered the lunar orbit. The ADG module is still finding and fixing bugs and upgrading functions for user convenience. This paper briefly deals with the initial operation results and the functional

improvement of ADG module upgraded from the design and development and also defines the current operational kernels delivered to the science payload developers.

[P-60] Zero Offset Determination of KPLO Magnetometer Using Davis-Smith Method in the Interplanetary Magnetic Field

Wooin Jo[1], Ho Jin[1], Khan-Hyuk Kim[1], Hyeonhu Park[1], Junhyun Lee[1], Yunho Jang[1], Hyeonji Kang[1], Juhyeong Kim[1], Seul-Min Baek[2]

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

The Korea Pathfinder Lunar Orbiter (KPLO) officially arrived at the Moon on December 27, 2022 (KST), after a 4.5-month Ballistic Lunar Transfer (BLT) orbit. The payloads of KPLO are carrying out their own respective scientific missions in lunar orbit at 100 km altitude. The KPLO MAGnetometer (KMAG) has three fluxgate magnetometers inside a 1.2-meter boom. The scientific objectives are investigating the lunar surface magnetic field and near-Moon space environment. Although the lunar magnetic anomalies have relatively strong magnetic fields, the magnetic field strength is expected to be less than 1 nT at a 100 km altitude orbit. In addition, zero level offsets change over time due to many reasons, such as temperature changes in sensors, artificial variation of the spacecraft magnetic field distortions. Therefore, the zero level offset is an important factor for raw data.
For the initial method to find the offset values, we choose the Davis-Smith (D-S) method (Davis & Smith 1968; Belcher 1973) using minimum variance analysis with Alfvénic wave in solar wind. Applying the derived daily offsets, the difference between KMAG and DSCOVR data is less than 0.2 nT in the average value and less than 0.1 nT in the standard deviation value.

[P-61] Using Hapke Radiative Transfer Model with RELAB Spectra in Lunar Science

Eunjin Cho[1,2], Young-Jun Choi[1,2]

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

The Hapke radiative transfer model (RTM) is a widely used tool in planetary science to study the particulate surface. Researchers can use this model to derive maps of mineral abundances and submicroscopic metallic iron (SMFe) on the lunar surface and to extract information such as mineral abundances, SMFe content, and particle sizes from the lunar samples. In this study, we briefly introduce the influence of SMFe content and particle sizes on the sample spectra by using Hapke RTM and RELAB data. This work will be helpful to next step for analyzing lunar surface spectra observed by remote sensing.

[P-62] Trace of Lunokhod Rovers on the Moon with Satellite Images

Ik-Seon Hong[1,2], Yu Yi[2]

[1]*Korea Institute of Geoscience and Mineral Resources*
[2]*Chungnam National University*

Lunokhod 1 and 2 were lunar exploration rovers operated by the Soviet Union in the 1970s. They landed at Mare Imbrium and Le Monnier crater and moved about 10 km and 40 km, respectively, to capture images of the lunar surface. By comparing the captured images with recent satellite images, it is possible to attempt to match the texture of the actual topography in the satellite images. In preparation for future lunar exploration rover missions in Korea, it is expected that the actual terrain can be inferred from satellite images of the landing site.

[P-63] Current Status of Atmospheric Entry Capsule Development for TPS Verification

Dae-Yeong Kim, Gi-Hyuk Choi

Korea Aerospace Research Institute

Atmospheric entry test using capsule in development of thermal protection system can find out the ablation characteristics by aerodynamic heating. Representative atmospheric entry capsules include Reentry Breakup Recorder (REBR), Small Probe for Orbital Return of Experiments (SPORE), Small Probe Reentry Investigation for TPS Engineering (SPRITE), Micro Return Capsule 2 (MIRKA 2), Small Earth Reentry Vehicle for Biological Sample Return (BioDOME), QubeSat for Aerothermodynamic Research and Measurements on AblatioN (QARMAN). Each capsule was used to performance verification of the ablative material for the thermal protection system. There are cases of success, but there are also cases of failure due to problems such as communication technology. It is an essential critical technology for space exploration in the future.

[P-64] Technical Aspects of Space Frequency Coordination for Space Traffic Management

Okchul Jung, Jaedong Seong, Youeyon Jung, Saehan Song, Daewon Chung

Korea Aerospace Research Institute

The Interagency Operations Advisory Group (IOAG), founded in 1999, is identifying common needs across multiple agencies related to mission operations, space communications, and navigation interoperability. KARI (Korea Aerospace Research Institute) is also participating in the Space Operations

Sustainability Working Group (SOS WG) to share concerns on the evolution of the operations in space due to the rapid increase of operational satellites and the growing population of catalogued space debris and to evaluate if the existing processes and coordination are sufficient. This paper describes the key findings in the domain of spectrum and interferences and related recommendations to space agencies, the Space Frequency Coordination Group (SFCG), ground station operators and service providers, national and international regulators, satellite designers and operators. The LTS (Long term sustainability) of operations in space can only be achieved via strong international collaboration and agreements leading potentially to common regulations through STM (Space Traffic Management).

[P-65] Space Object Conjunction Assessment Activities for KARI Satellite Constellation in 2022

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

Korea Aerospace Research Institute

As of March 2023, KARI operates five low-orbit satellites (KOMPSAT, CAS500 series) and three geostationary satellites (GEO-KOMPSAT). Space object collision monitoring activities are carried out 24 hours a day for safe mission performance of operating satellites, and this paper shows the current status of collision monitoring activities and major events and statistical analysis results for 2022. It also included the results of optical observation campaigns conducted with foreign private companies.

[P-66] Analysis of SLR Observation Effects according to Photographic Range of Low-Earth Orbit Ground Observation Satellites

Seok-Min Song[1,2], Mansoo Choi[1], Yu Yi[2]

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

Today, in the use of space, numerous satellites for each purpose are orbiting the Earth to fulfill their respective roles. Among them, satellites observing the ground are increasingly at risk of stealing information from security facilities, mainly military facilities, as their resolution begins to improve. To protect this, various technologies that hinder their observation are continuously being studied. Accordingly, we confirmed the direction of the reconnaissance satellite's progress through orbital propagation of seven high-resolution satellites operating in actual low orbit, and identified the observable range that varies depending on the satellite's altitude and Off-Nadir angle. In addition, three types of situations that can be produced along with satellite observation through satellite laser Ranging (SLR), a system that measures the bidirectional time of flight between the ground station and the satellite using a laser, were classified. Through this, it calculates a timeline in which a reconnaissance satellite can photograph on region of interest. And accordingly, check the SLR can response by each situation.

[P-67] Study on Break-Up Model for Space Environment Management

Youeyun Jung, Jaedong Seong, Saehan Song, Okchul Jung

Korea Aerospace Research Institute

Since it is difficult to estimate the exact parameters for all break-up events, techniques have been studied for modeling from a statistical distribution that can estimate parameters based on the data of the break-up events that have occurred so far. In this study, starting with NASA's EVOLVE model, the improvement of LEGEND and the method of deriving fragment size distribution, cause of break-up events, mass to area ratio distribution, velocity increment distribution for each model of POEM, the ESA model, are investigated. The difference was compared with the parameter distribution derived by these models and the distribution obtained from the actual break-up events.

[P-68] Operation of Ground GNSS in NMSC and Assessment of the Quality of Precipitable Water Vaper between Nearby GNSS Station on Radio-Sonde Station

Jun-Ho Kim, Tae-Kyu Jang

Satellite Operation Division, National Meteorological Satellite Center (NMSC)

The NMSC (National Meteorological Satellite Center) has been developing a near realtime GNSS (Global Navigation Satellite System) operation system that can process atmospheric parameters, such as Zenith Total Delay (ZTD), Precipitable Water Vaper (PWV). These parameters are assimilated into Numerical Weather Prediction (NWP) medels.
In this paper, we introduce the Ground GNSS automated processing system in NMSC. we compared the PWV estimates from nearby Radio-Sonde station in order to assessment of the quality of GNSS observation data. Also, AWS observation data is used to processing PWV estimates, we analyses the accuracy range of PWV according to the distribution and the number of AWS.

[P-69] K-DRIFT Testbed Installation at BOAO

Yongseok Lee[1,2], Jongwan Ko[1], Changsu Choi[1], Gyusu Park[1], Youngbeom Jeon[1], Woowon Byun[1], Jaewoo Kim[1], Yunjong Kim[1], Gayoung Lee[1,3], Hyun-Il Sung[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*School of Space Research, Kyung Hee University*
[3]*Department of Astronomy and Atmospheric Sciences, Kyungpook National University*

We installed a testbed for K-DRIFT performance testing and verification at the Bohyunsan Optical Astronomy Observatory (BOAO). The K-DRIFT testbed consists of two fully-opened domes and one control room. In order to install the testbed, we conducted a ground structure investigation of the BOAO to confirm the stability of the testbed's location and performed ground resistance measurements to design and install appropriate grounding. We also conducted structural analysis of various external environments to verify the structural stability of the testbed. Based on these results, we installed the K-DRIFT testbed at the BOAO stably and plan to conduct performance testing and verification of the developing K-DRIFT telescope through this testbed.

[P-70] A Study on the Establishment of a Satellite Technology Data Management System through Agile Project Management Methodology

Chul Kang

Korea Aerospace Research Institute

In this paper, we aim to explore the Agile project management methodology and propose a plan to establish a satellite technology data management system utilizing this approach. To build a satellite technology data management system, we investigate the characteristics of satellite technology data and analyze the initial requirements and problems of existing technology data management systems.

We also discuss the limitations of traditional project management approaches and introduce the Agile project management methodology's development declaration and principles. Furthermore, we propose a methodology to construct a satellite technology data management system using this approach. The Agile project management methodology allows for flexibility in responding quickly to changing requirements by incorporating incremental development and collaborating with customers and users to reflect their needs actively. Additionally, it involves performing a repetitive cycle of development stages to achieve the development goal by producing small units of results leading to the final output. This methodology can effectively apply to building complex systems by actively accommodating changing requirements while increasing development speed and quality.

Therefore, in this paper, we propose a plan to construct a satellite technology data management system using the Agile project management methodology.

[P-71] A Study on the Relationship between Input Noise Frequency and Output Spur Level When Measuring the DC Supply Noise Using a Voltage-Controlled Oscillator

Hyojun Kim

Korea Aerospace Research Institute

Emissions of DC supply voltage noise can degrade electromagnetic compatibility (EMC) performance. Since DC supply voltages in spacecraft are tens of volts that can damage instrument equipment, measurement of the supply voltage noises should be carefully considered. Using an attenuator is one of the solutions to prevent from damaging the instrument equipment, but the attenuator also attenuates the supply noise. To solve this issue, the supply noise can be measured by using a voltage-controlled oscillator (VCO) which converts a voltage signal into a frequency signal. For example, a single tone of the voltage noise converts into a spurious tone at the VCO output. The VCO can easily cut off the DC offset voltage without an attenuator or high-pass filter. However, the signal transfer function of the VCO is not a unity gain. In this study, analysis and demonstration of the relationship between the noise frequency of the input voltage noise and the output spur level of the VCO are presented.

[P-72] SpaceAI: A Program for Breaking through Challenges in Space Science and Technology with Artificial Intelligence

Sung-Hong Park[1], Seonghwan Choi[1], Jihye Baek[1], Eunsu Park[1], Jeongheon Kim[1], Hwanhee Lee[1], Roksoon Kim[1], Jongyeob Park[1], Sujin Kim[1], Young-Sil Kwak[1], Yong-Jae Moon[2], Taeyoung Kim[3]

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

SpaceAI is an annual multidisciplinary program that scientists, software engineers, IT industries as well as students and citizens all participate in as various project teams, each of which aims to solve a targeted, peer-reviewed question in space science and technology with artificial intelligence (AI). The program consists of a scientist track and a citizen scientist track. The scientist track helps participants carry out a proposal-based research with support from the program advisory committee, suggesting the best matching experts on the proposed topic, providing IT infrastructure resources and delivering/promoting products in the forms of publications and software applications. The citizen scientist track opens up opportunities for students and citizens to have hands-on training in AI with a variety of observation data used in space science. We welcome your suggestions for maximizing the practical use of this program and encourage your participation. The details and schedule of this year

SpaceAI program can be found in the following webpage: https://spaceai.kasi.re.kr.

[P-73] A Trend Analysis for 2018-2022 Aerospace Research Theme

Jang-Won Suh, Yong-Sik Yoon, Su-Hyun Ock

Korea Aerospace Research Institute

In order to Identify technology trends and to predict future technology development directions, this research performs an analysis of research themes in Aeronautical and Aerospace (Satellite and Launch vehicle) fields.
In this study, keyword analysis was performed on the papers of the following 5 science societies for 5 years (2018-2022) in Aerospace field.

- The Korean Society for Aeronautical & Space Sciences
- The Korean Society of Propulsion Engineers
- The Korean Space Science Society
- The Institute of Positioning, Navigation, and Timing
- The Society for Aerospace System Engineering

This study found followings;

■ Aeronautical field
- Main field of study is the fixed wing UAV field (52%). It seems that this is due to the recent high interest in UAVs in the field of defense.
- The second & third field of studies are Certification & Qualification and Propulsion.

■ Aerospace (Satellite) field
- The representative keywords in the satellite field are Nanosatellite (20.3%), Orbit determination (14.4%), Lunar orbiter (13.1%), and Satellite (7.8%) respectively. Especially in the Nanosatellite field, it is given a lot of attention to Micro-satellites including Can-sat and Cube-sat.
- In the field of satellite navigation, papers were produced in the order of GNSS (19.6%) and GPS (17%).

■ Aerospace (Launch vehicle) field
- The studies are performed 52.6% in Liquid propulsion, 29.2% in Launch vehicle, 10.4% in Solid propulsion and 7.8% in Solid rocket motors.
- In particular, the proportion of research on reusable rockets in the Launch vehicle field is increasing.

[P-74] Development and Industrialization of Satellites througn Keyword Search Trend

Keun-Woong Shin, Ji-Mo Yang, Kyung-Jin Kwon, Chul Kang, Jong-Hwi Choi, Eung-Sik Park

Korea Aerospace Reasearch Institute

In the era of private-led new-space, the industrialization of satellite development is also drawing attention. In this paper, some keywords related to the industrialization and development of satellite are selected, and domestic responses are briefly reviewed through keyword search trend.

[P-75] Test Method for LOS Matching between Optical Modules

Jeeyeon Yoon, Jeoung-Heum Yeon, HaengPal Heo

Korea Aerospace Research Institute (KARI) Satellite Payload R&D Division

In this paper, We introduce the test method for LOS matching between optical modules of Earth observation camera. Our earth observation camera includes a high resolution optical system and has an optical module installed to add cameras of different focal lengths. Depending on the assembly and alignment of additional optical modules, there may be a difference between the LOS of the image created by the front end optical system and the LOS of the final detector. For this reason, Test method was proposed to check the alignment of additional optical modules in order to match the front end optical system with additional optical modules and the line of sight on the imaging surface. This is a test form that checks the intermediate imaging surface made by the basic optical system and the imaging position of the final detector. By assembling and aligning the center of the image produced by the optical system, the camera can be manufactured without impairing image performance.

[P-76] Utilizing Geochang SLR System for Optical Ground Station in Space-To-Ground Laser Communication

Ki-Pyung Sung, Hyung-Chul Lim, Mansoo Choi, Sung-Yeol Yu, Jonguk Park

Korea Astronomy and Space Science Institute

There are more than 40 stations for the satellite laser ranging (SLR) in the world. Many SLR stations have been used as the optical ground stations for the space-to-ground laser communication because it demands enormous expense to establish a optical ground station. Geochang SLR system consists of the satellite laser ranging, adaptive optics and laser tracking experiment modules. The three modules are operated independently by rotating the switching mirror inside the telescope pedestal which feeds the beam path to each module. In particular, the experiment module was designed for the useful experiment such as the space debris laser tracking, laser communication and high power laser propagation based on adaptive optics. So we address the utilization of Geochang SLR system with a 100 cm telescope for an optical ground station.

분과회 소개 및 활동

우주감시분과

"우주감시분과"는 우주공간의 환경 보호와 감시, 우주위험의 예방 및 대비 등 우주상황인식 및 우주위험감시 분야에 대한 학술활동 및 네트워크 구축을 위하여 설립되었습니다. 본 분과는 한국천문연구원 박장현 회원을 초대 분과장으로 하여 2018년에 시작되었고, 한국천문연구원 최은정 회원이 2021-2022년 분과장을 맡아 활동하였습니다. 현재 KAIST 안재명 회원이 2023-2024년 분과장을 맡고 있고, 한국항공대학교 이동헌 회원이 간사를, ㈜솔탑 강병국 회원, 한국천문연구원 김명진 회원, 세종대학교 김은희 회원, 한국항공우주연구원 성재동 회원, 한국천문연구원 최진 회원이 운영위원으로 활동 중입니다.

우주감시분과에서는 매년 우주과학회 봄/가을 학술회의에서 우주감시 Organized Session과 우주감시분과 워크숍을 개최하며, 해당 분야 연구 정보 공유와 저변 확대를 위해 노력하고 있습니다. 2023년 봄 우주감시분과 워크숍은 4월 27일, 우주과학회 춘계학술회의기간 중 "우주 위험 감시 연구 개발 현황 공유 및 협력 워크숍"으로 개최됩니다.

우주감시분과에서는 학계, 산업계, 연구기관, 그리고 군에 소속된 70여 명의 회원들이 적극적으로 활동 중입니다. 관심 있는 회원님들의 많은 참여를 기대합니다.

우주관측기기분과

■ 소개

우주관측기기 분과는 천문우주관측기기 관련 연구 활동을 증대하기 위해 2018년 5월 봄학술대회 때 창립총회를 거쳐 탄생하였습니다. 당시 47명의 회원으로 한국천문연구원 문봉곤 책임연구원을 초대 분과장으로 선출하였고, 또한 2기 분과장으로 재임하였습니다. 2022년 10월에 3기 분과장으로 한국천문연구원 한정열 책임연구원이 새로 취임하였습니다. 우리 분과는 한국천문학회 천문관측기기분과와 공동으로 매년 천문우주관측기기워크숍을 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 이슈를 논의하고, 이에 대한 학술적인 지원과 정책적 판단의 자료를 공유하고 있습니다.

■ 활동내역

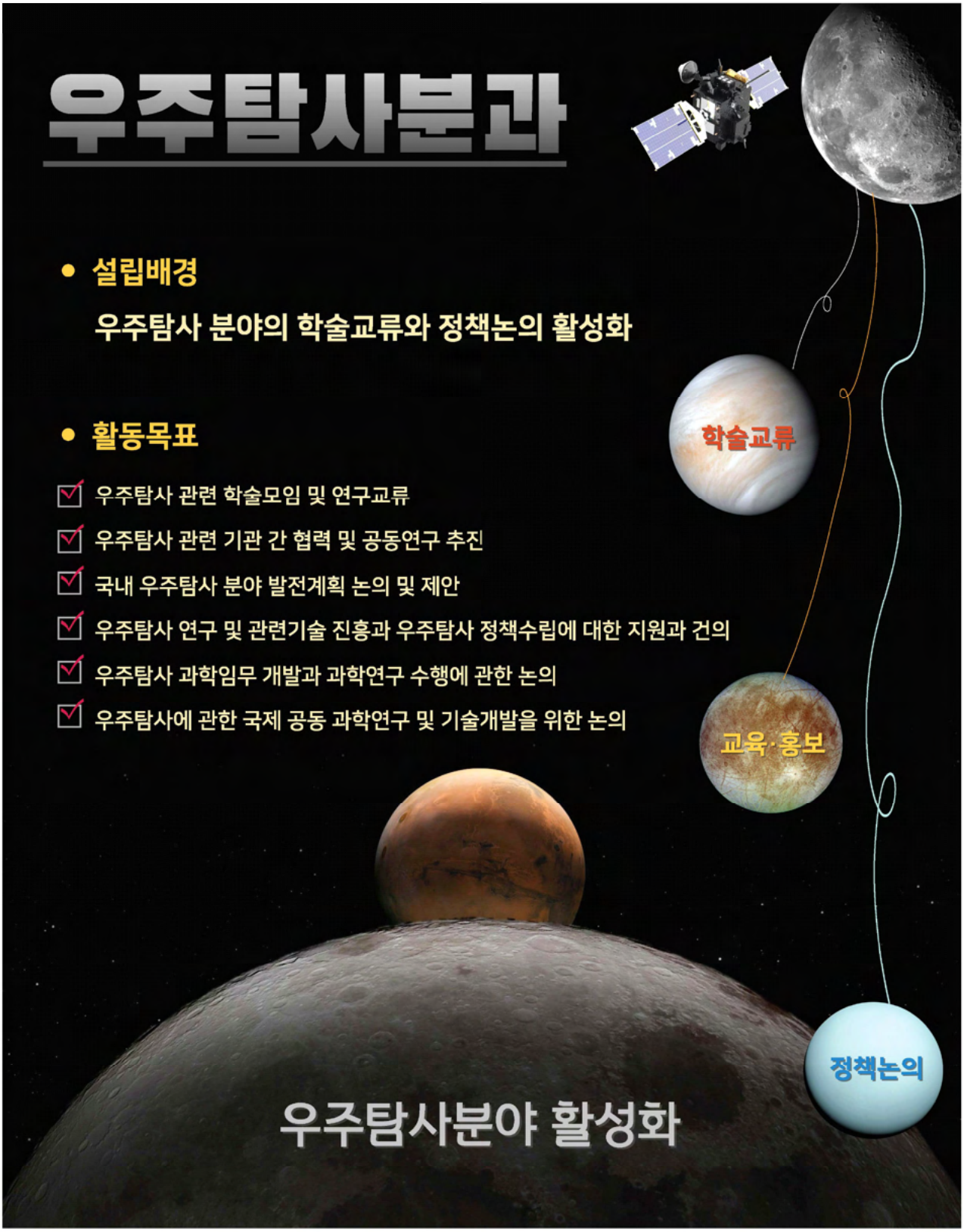
2018년부터 재개한 천문우주관측기기 워크숍이 2022년 12회째 진행되고 있습니다. 2022년 행사는 한국우주과학회 우주관측기기 분과의 임원이 중심이 되고, 한국천문학회 천문관측기기분과의 임원과 함께 조직위원회를 구성하였으며, KGU(Korea Geoscience Union) 연례 학술대회의 일환으로 진행하였습니다. 2022년 천문우주관측기기 워크숍은 3일간 6개의 발표세션에서 총 112명의 참석자가 모여 30개의 구두발표가 있었습니다. 레오스페이스, ㈜에스엘랩, ㈜에이디솔루션, ㈜아이트릭스, 충북Pro메이커센터, ㈜카이로스페이스 등 6개 패밀리 기업이 참가하고, 16명의 천문우주학 및 관측기기 관련 대학교 학부생 참가를 지원했습니다.

■ 계획

2023년에도 한국천문학회 천문관측기기분과가 주도하는 천문우주관측기기 워크숍에 공동 주관을 맡아 진행합니다. 아울러 우리 분과는 SPIE(The International Society for Optics and Photonics) 국제 컨퍼런스의 국내 유치를 준비하고 있습니다.

2022 천문우주관측기기 워크숍 기념촬영

2022 천문우주관측기기 워크숍 패널 토론자 기념촬영



한국우주과학회 우주탐사분과

분과장 김주현(kl0630@kari.re.kr)
간사 심채경(cksim@kasi.re.kr)

초소형위성 분과

■ 소개

초소형위성 분과는 2019년 10월 창립을 준비하여 2020년 4월 춘계학술대회부터 출발하여 이제 4년째를 맞이하고 있습니다. 초대 충남대 이유 교수님에 이어서 2021년 10월부터 경상국립대 김해동 교수가 2대 분과장을 맡고 있습니다. 초소형위성 분과는 뉴스페이스 시대를 맞이하여 대학, 연구기관뿐만 아니라, 산업체와 군, 정부기관에서도 많은 관심을 가지는 초소형위성의 개발, 활용 및 응용과 관련된 국가 정책 제안, 기술 정보 교류 및 산학연 네트워크를 구축하고자 창설되었습니다. 현재 총 41명의 회원들이 활동하고 있습니다.

■ 2022년 활동

초소형위성 분과는 2020년부터 국내 유일의 '초소형위성 워크샵'의 주최/주관을 맡아왔으며, 초소형위성 분과 회칙의 개정을 통해 '초소형위성 워크샵'의 주관 분과로서의 역할을 명확하게 명시하였습니다. 2022년 초소형위성 워크샵은 총 300명이 참석하여 성황리에 마친 바 있습니다.

■ 2023년 계획

초소형위성 분과는 올해 8회째를 맞이하는 초소형위성 워크샵을 6월 1-2일 부산 해운대 웨스틴조선호텔에서 개최할 예정이며, 우주항공청 출범을 앞두고 초소형위성을 매개로 하는 신 우주산업 전반에 걸친 다양한 발표주제를 준비하고 있습니다. 특히, 2023년부터는 부산광역시가 초소형위성 워크샵의 공식 후원 지자체로써 참여할 예정이며, 400명 가까운 역대 최대 규모를 예상하고 있습니다.

태양우주환경 분과

태양우주환경 분과는 한국천문연구원 곽영실 회원을 초대 분과장으로 2016년부터 시작되었으며, 2년 임기로 2018-2019년 KAIST/SaTRec 유광선 회원, 2020-2021년 전남대학교 오수연 회원, 2022-2023년 극지연구소 지건화 회원이 현재 분과장을 맡고 있습니다. 태양우주환경 분과는 우주과학회 내 고층대기, 자기권, 태양 분야에서 연구활동을 수행하고 있는 분과회원으로 참여하고 있으며, 2022년 6월 현재 약 101명의 회원이 소속되어 있습니다.

주요 활동으로는 매년 분과회원들을 대상으로 워크숍을 개최하여 분과 회원들 및 유관 기간 간 연구현황 등을 공유하여 공동연구의 장을 마련하고 있으며, 특히 학생들의 향후 연구활동을 위한 교육 및 동기 부여를 위해 고층대기, 자기권, 태양 분야의 튜토리얼 강좌를 수행하고 있습니다. 현재까지 한국천문연구원, 극지연구소 등의 지원을 통해 매년 7월경에 워크숍을 개최해 왔으며, 최근에는 KGU 학회 내 특별세션 형태로 개최되기도 했으며, 2023년 워크숍은 극지연구소에서 7월에 개최될 예정입니다.

2021년(분과장 오수연 회원)에는 국내 태양우주환경 분과와 관련하여 수행되고 있는 국내 우주환경 관측활동 및 모델연구 현황을 정리하여 태양 · 행성 간 공간, 자기권, 고층대기 분야에서 3편의 논문으로 한국우주과학회 '우주기술과 응용'에 발표되었습니다(국내 우주환경 자료 보유 현황, Journal of Space Technology and Applications. Vol. 1, No. 2, 2021).

2023년 분과활동 계획으로 7월 분과 워크숍 개최와 함께 태양우주환경 분과에서 통용되고 있는 한글 용어를 정리하는 일을 추진하고 있습니다. 최근 언론, 산업체, 정부 및 공공기관, 학계 등에서 기후변화, 태양활동, 우주기상 등에 대한 다양한 한글 용어가 사용되고 있는데, 이때 관련 용어들이 통일되어 있지 못해 혼란이 초래되는 경우가 있습니다. 따라서 국내 우주환경 관련 산 · 학 · 연에 통일된 한글 용어를 제안하려는 목적으로 추진 중에 있습니다.

마지막으로 태양우주환경 분과 관련 소식 등을 공유하고자 분과 홈페이지를 준비하고 있고, 이 홈페이지를 통해 워크숍 공지, 분과 회원 동정, 분과 관련 기관소식 등을 공유하고자 합니다.

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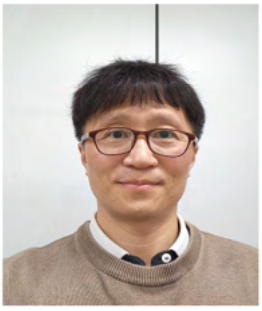

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김지석(한국항공우주연구원)

한국우주과학회보
제32권 1호 2023년 4월
전화 042-865-3391 (FAX: 042-865-3392)
학회 홈페이지 http://ksss.or.kr

발행인 이 유
편집인 정종균 · 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