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2022년 10월 제31권 2호

사단법인 한국우주과학회
The Korean Space Science Society

차 례

<사단법인 한국우주과학회 입회 안내>

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

▣ 보낼곳: 한국우주과학회
34055 대전광역시 유성구 대덕대로 776
한국천문연구원 내
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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]
한국천문연구원은 우주개발진흥법에 의거하여 과학기술정보통신부가 지정한 우주환경감시기관으로서, 우주감시 장비 구축과 운영, 우주위험 정보분석, 우주위험 대응체계 구축 등 국가 우주상황인식 전문연구기관의 임무를 수행

입 회 원 서

<table>
<tr><td>성 명</td><td colspan="2">한글
영문</td><td>성 별</td><td>남/여</td><td>생 년 월 일</td><td colspan="2">년 월 일</td></tr>
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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>
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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
2022년 가을 학술대회

일　　시 : 2022. 10. 26.(수) ~ 28.(금)

장　　소 : 라마다 프라자 제주

발표논문 : 초청강연 6편, 구두발표 98편, 포스터발표 152편, 총 256편

포스터 집중 발표 1부 : 2022. 10. 27.(목) 14:50~16:20

2부 : 2022. 10. 28.(금) 09:40~11:00

후　　원 : KOFST 한국과학기술단체총연합회

한국과학창의재단 Korea Foundation for the Advancement of Science & Creativity

THE SATELLITE BREWING CO.

KAMS 한국마이크로중력학회 The Korean Microgravity Society

사단법인 한국우주과학회

등록 및 안내

1. 등록

회원의 등록비는 270,000원이며, 학생회원과 정회원 중 석·박사과정(전일제) 학생은 150,000원입니다. 사전등록을 하신 회원은 학회보, 명찰을 수령하시기 바랍니다. 등록비 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: 포스터 발표는 1부는 10월 26일(수) 16시까지 지정된 장소에 게시하고, 28일(금) 9시까지 수거해 주시고, 2부는 28일(금) 9시 30분까지 게시하고 28일(금) 12시에 수거하여 주시기 바랍니다. 집중발표 시간에 발표자는 자신의 포스터 앞에서 회원들의 질문에 답할 수 있도록 준비해 주시기 바랍니다. 위촉된 심사위원이 우수 포스터발표를 선정하여 폐회식 때 시상을 합니다. 포스터를 부착하지 않거나 학회 종료 후 수거하지 않은 회원은 추후 학회발표가 제한될 수 있습니다.

3. 발표장

Ramada Ballroom I	Ramada Ballroom II	Ramada Ballroom III	Ramada Ballroom IV	Lobby
- 기조강연 - Invited Talk (I), (II), (III), (IV), (V) - 태양 및 우주환경 (I), (II), (III) - SS: Space Laser Communication - 우주응용	- SS: 대중천문 - 달과 우주탐사: 과학기술 그리고 정책 (I), (II), (III)	- 우주기술 - 안보우주 - SS: 과학문화 - SS: Open New Horizon with L4 Mission	- 지상 및 우주 인프라 운영기술 - 우주감시 - 우주천문	포스터 발표

4. 교통 안내

가. 주소: 제주특별자치도 제주시 탑동로 66 (Tel: 064-729-8100)
나. 제주공항에서 호텔까지: 총거리 3.8 km ‖ 약 10분 소요 ‖ 택시 이용 시 5,000원 내외 소요
다. 공항 셔틀버스 운행 안내

5. 구두발표 색인표

I - 1 - 1
세션번호 발표장 발표순서

2022 KSSS FALL CONFERENCE PROGRAM

Oct. 26. (Wed)

Time	Functions
	차세대중형위성3호 탑재체 ROKITS 과학위원회 워크숍 2022년 10월 25일(화) 14:00~10월 26일(수) 11:40 / 2층 비양홀
10:00~12:00	**Tutorial : Ramada Ballroom II** 강사 : 이상우 (SELab, Inc.) 주제 : IDL 프로그래밍에 의한 우주과학 데이터 처리
13:00~	**Registration : Ramada Ballroom 2F**
14:00~14:10	**Opening Ceremony : Ramada Ballroom I** 환영사 : 이 유 회장 축사 : 김동수 육군본부 정책 실장
14:10~14:40	**기조강연** **Room : Ramada Ballroom I** Chair : 최호성 (육군) 이승민 (육군 우주정책 과장) Army Space Power Development Plan For Leading The National Space Industry
14:40~14:50	Coffee Break
14:50~15:20	**Invited Talk I** **Room : Ramada Ballroom I** Chair : 곽영실 (천문연) 길효섭 (APL) Satellite Exploration of the Earth's Upper Atmosphere
15:20~15:30	Coffee Break

Room	Ramada Ballroom I		Ramada Ballroom II		Ramada Ballroom III		Ramada Ballroom IV	
Session I	**태양 및 우주환경 I** Chair : 이환희 (천문연)		**SS: 대중천문** Chair : 김상혁 (천문연)		**우주기술** Chair : 임조령 (항우연)		**지상 및 우주 인프라 운영기술** Chair : 한정열 (천문연)	
15:30~15:45	I-1-1	강수상	I-2-1	조아라	I-3-1	서석배	I-4-1	정태현
15:45~16:00	I-1-2	손동효	I-2-2	서영준	I-3-2	문신혜	I-4-2	이충욱
16:00~16:15	I-1-3	Miyasita Yukinaga	I-2-3	김신명	I-3-3	이준찬	I-4-3	이동주
16:15~16:30	I-1-4	Madeeha Talha	I-2-4	허 민	I-3-4	안상일	I-4-4	김명진
16:30~16:45	I-1-5	정세헌			I-3-5	정다운	I-4-5	정종균
16:45~16:55	I-1-6	이환희						
16:55~17:05	Coffee Break							
17:05~17:35	**Invited Talk II** **Room : Ramada Ballroom I** Chair : 김명진 (천문연) 이연주 (IBS) Hot News on Hot Venus							
	각 분과 총회 및 이사회							

Oct. 27. (Thu)

Time	Functions							
09:00~09:30	**Invited Talk III** Room : Ramada Ballroom I Chair : 양홍진 (천문연) 이형목 (SNU) Preparations for Registering Astronomical Observation Logs of Joseon Dynasty in the UNESCO's Memory of the World							
09:30~09:40	Coffee Break							
Room	**Ramada Ballroom I**		**Ramada Ballroom II**		**Ramada Ballroom III**		**Ramada Ballroom IV**	
Session II	**태양 및 우주환경 II** Chair: 이창섭 (극지연)		**달과 우주탐사: 과학기술 그리고 정책 I** Chair : 김주현 (항우연)		**안보 우주** Chair : 최호성 (육군)		**우주감시** Chair : 최 진 (천문연)	
09:40~09:55	II-1-1	이시백	II-2-1	전문진	II-3-1	이금오	II-4-1	성기평
09:55~10:10	II-1-2	이창섭	II-2-2	송영주	II-3-2	이찬행	II-4-2	민상웅
10:10~10:25	II-1-3	고영경	II-2-3	방 준	II-3-3	이준성	II-4-3	이은지
10:25~10:40	II-1-4	윤종연	II-2-4	배종희	II-3-4	송세찬	II-4-4	최진
10:40~10:55	II-1-5	이지이	II-2-5	홍승범	II-3-5	김방엽	II-4-5	김윤학
10:55~11:05	Coffee Break							
11:05~11:20	II-1-6	이호진	II-2-6	임조령	II-3-6	정종균	II-4-6	김시우
11:20~11:35	II-1-7	홍준석	II-2-7	김인규	II-3-7	이재진	II-4-7	홍정유
11:35~11:50	II-1-8	서지우	II-2-8	이병선	II-3-8	강경인	II-4-8	조중현
11:50~12:05	II-1-9	박이경	II-2-9	홍익선			II-4-9	김한익
12:05~12:20	II-1-10	지은영					II-4-10	이수진
12:20~13:10	Lunch							
Session III	**SS: Space Laser Communication** Chair: 임형철 (천문연)		**달과 우주탐사: 과학기술 그리고 정책 II** Chair : 송영주 (항우연)		**SS: 과학문화** Chair : 조중현 (천문연)		**우주감시 워크숍 & 분과총회**	
13:10~13:25	III-1-1	13:10~13:30 엄만석	III-2-1	진호	III-3-1	황정아	최은정 (천문연) 김은희 (세종대) 전상미 (LIGNex1) 이현재 (한화시스템) 임병균 (항우연) 분과총회: 김명진(천문연)	
13:25~13:40	III-1-2	13:30~13:50 최기환	III-2-2	김관혁	III-3-2	김현옥		
13:40~13:55	III-1-3	13:50~14:10 임형철1	III-2-3	조우인	III-3-3	강신철		
13:55~14:10	III-1-4	14:10~14:30 임형철2	III-2-4	이종훈	III-3-4	이명현		
14:10~14:25			III-2-5	정민섭	패널토의			
14:25~14:40			III-2-6	이연주				
14:40~14:50	Coffee Break							
14:50~16:20	**Poster Session I**							
16:20~16:50	**Invited Talk IV** Room : Ramada Ballroom I Chair : 정종균 (천문연) 김예동 (SCAR) Current Status and Future of the Antarctic Research Activity in Korea							
16:50~17:00	Photo Time							
17:00~18:00	**Regular General Meeting : Ramada Ballroom II**							
18:00~20:30	**Banquet : Ramada Ballroom I**							

Oct. 28. (Fri)

Time	Functions							
09:00~09:30	**Invited Talk V** **Room : Ramada Ballroom I** Chair : 이 유 (충남대) 김대관 (KARI) 대한민국 달 궤도선 '다누리' 개발과 여정 Development and Journey of Korea Lunar Orbiter 'DANURI'							
09:30~09:40	Coffee Break							
09:40~11:00	**Poster Session II**							
Room	**Ramada Ballroom I**		**Ramada Ballroom II**		**Ramada Ballroom III**		**Ramada Ballroom IV**	
Session IV	**태양 및 우주환경 III & 우주응용** Chair: 고대호 (항우연)		**달과 우주탐사: 과학기술 그리고 정책 III** Chair : 서행자 (인스페이스)		**SS: Open New Horizon with L4 Mission** Chair : 최광선 (경희대)		**우주천문** Chair : 전준혁 (충북대)	
11:00~11:15	IV-1-1	우창호	IV-2-1	백길호	IV-3-1	조경석	IV-4-1	김일훈
11:15~11:30	IV-1-2	남욱원	IV-2-2	김한익	IV-3-2	황정아	IV-4-2	김상혁
11:30~11:45	IV-1-3	곽재영	IV-2-3	박현후	IV-3-3	임은경	IV-4-3	민병희
11:45~12:00	IV-1-4	정대준	IV-2-4	김푸름	IV-3-4	이진성	IV-4-4	박은미
12:00~12:15	IV-1-5	고대호	IV-2-5	이진아	IV-3-5	박진혜	IV-4-5	전준혁
12:15~12:30	IV-1-6	신근웅	IV-2-6	김현준	IV-3-6	정현진		
12:30~12:45	**Closing Ceremony : Ramada Ballroom I** 우수 구두발표상, 우수포스터상 시상식							
13:00~17:00	제주 Field Trip 제주에서 만난 우주 - 제주 용암동굴, 달 탐사로버 시뮬레이션							

Poster Session

1부 : 10. 27. (Thu) 14:50~16:20

Area	No	Author	Area	No	Author
달과 우주 탐사	P-1	강상욱	우주기술	P-39	강금실
	P-2	김대영		P-40	강범석
	P-3	김동규		P-41	강수연
	P-4	김일훈		P-42	강우용
	P-5	김재인		P-43	권경진
	P-6	김창균		P-44	권재욱
	P-7	문상만		P-45	김경근
	P-8	방 준		P-46	이상록
	P-9	백슬민		P-47	김기덕
	P-10	송재훈		P-48	김동오
	P-11	안상일		P-49	김명길
우주감시	P-12	오태봉		P-50	김민준
	P-13	장수영		P-51	김용복
	P-14	장호우		P-52	김의근
	P-15	전상미		P-53	김준호
	P-16	정옥철		P-54	김진혁
	P-17	정유연		P-55	김진형
	P-18	최철희		P-56	김태효
태양 및 우주환경	P-19	Daniel Milosic		P-57	김희경
	P-20	Hoang Ngoc Huy Nguyen		P-58	도재휘
	P-21	곽재영		P-59	문홍열
	P-22	권종우		P-60	민승용
	P-23	김보경		P-61	박균상
	P-24	김성환		P-62	박근주
	P-25	김수진		P-63	박봉규
	P-26	김정헌		P-64	박성우
	P-27	민경국		P-65	박성욱
	P-28	박경선		P-66	박수현
	P-29	봉수찬		P-67	박종석
	P-30	손동희		P-68	박종오
	P-31	송호섭		P-69	박주호
	P-32	오수연		P-70	박홍원
	P-33	이동희		P-71	방수완
	P-34	정종일		P-72	백광열
	P-35	조세진		P-73	백현철
	P-36	조유진	지상 및 우주 인프라 운영기술	P-74	신동영
	P-37	한윤기		P-75	송석민
	P-38	황준영	초소형 위성	P-76	손종대

Poster Session

2부 : 10. 28. (Fri) 09:40~11:00

Area	No	Author	Area	No	Author
달과 우주 탐사	P-77	이덕행	우주기술	P-115	김구혁
	P-78	이재희		P-116	이서림
	P-79	이종원		P-117	이선호
	P-80	이준현		P-118	이우민
	P-81	이희재		P-119	이준호
	P-82	장종태		P-120	임은숙
	P-83	전문진		P-121	임현수
	P-84	정다운		P-122	장경덕
	P-85	조은진		P-123	장성수
	P-86	홍승범		P-124	전갑호
우주응용	P-87	김신욱		P-125	전정남
	P-88	김영선		P-126	전종협
	P-89	김영윤		P-127	전현진
	P-90	명환춘		P-128	조승원
	P-91	박종억		P-129	조창권
	P-92	박진형		P-130	최재동
	P-93	윤지연		P-131	한조영
	P-94	이성숙		P-132	허성식
	P-95	이종태		P-133	허윤구
	P-96	정대준		P-134	현정훈
우주천문	P-97	강현지		P-135	김민아
	P-98	김천휘		P-136	김유광
	P-99	서윤경	기타	P-137	강 철
	P-100	장윤호		P-138	강치호
우주기술	P-101	서석배		P-139	김민기
	P-102	송새한		P-140	류동옥
	P-103	신재민		P-141	배영조
	P-104	신현규		P-142	소민석
	P-105	신현진		P-143	육영춘
	P-106	양승은		P-144	이창은
	P-107	양정환		P-145	이태경
	P-108	양지모		P-146	이훈희
	P-109	연정흠		P-147	정재훈
	P-110	원영진		P-148	한정우
	P-111	윤석택		P-149	김춘원
	P-112	윤영수		P-150	안나균
	P-113	은희광		P-151	이태진
	P-114	이도경		P-152	김고은

한국우주과학회 2022 가을학술대회 튜토리얼

- **일시:** 2022년 10월 26일(수) 10시~12시
- **장소:** 라마다프라자 제주 Ramada Ballroom II
- **강사:** 이상우(SELab, Inc.)
- **주제:** IDL 프로그래밍에 의한 우주과학 데이터 처리
- **대상:** 학부생 대학원생 및 학회 참여자

IDL은 지난 40여 년에 걸쳐 과학기술 분야 특히 우주과학 및 천문학 분야의 연구자들 사이에서 폭넓게 사용되어온 프로그래밍 언어입니다. 데이터의 입력으로 시작하여 각종 수치계산 기법들에 의한 처리를 거쳐 최종 결과물을 획득하는 일련의 과정을 직관적인 문법의 프로그래밍에 의하여 구현할 수 있습니다. 우주과학 분야에서 주로 다뤄지는 데이터들을 보면 여러가지 형태가 존재합니다. 우리에게 익숙한 텍스트 및 그림 파일들과 같은 일반 포맷인 경우도 있지만, 복합형 특수 포맷의 파일들을 다루게 되는 경우도 꽤 많습니다. 따라서 이렇게 다양한 형태로 존재하는 원시 데이터를 읽고 처리하여 우리가 원하는 결과물을 얻는 과정들을 보면 매우 다양한 경우가 존재합니다.

이번 튜토리얼 세션에서는 이와 같이 다양한 사례들 중 몇 가지를 선별하여 그 기술적 과정을 주어진 시간 내에서 가급적이면 상세히 소개해 보고자 합니다. 일반 또는 특수 포맷의 우주관측 및 지구관측(원격탐사) 데이터를 읽고 처리하여 표출하고, 결과물도 생성하는 일련의 과정을 IDL 프로그래밍으로 구현하는 예제들을 다루게 될 것입니다. 이러한 예제들에서는 IDL의 데이터 입출력 기능, 배열 기반의 각종 수치계산 및 이미지 처리 기법들, 각종 그래픽 표출 기능 등이 다양하게 활용될 예정입니다.

차세대중형위성3호 탑재체 ROKITS 과학위원회 워크숍

- **제목:** 차세대중형위성3호 탑재체 ROKITS 과학 임무를 위한 워크숍
- **일시:** 2022년 10월 25일(화) 14:00~10월 26일(수) 11:40
- **장소:** 라마다프라자 제주호텔 2층 비양홀
- **행사개요**

2024년 말 누리호로 발사 예정인 차세대중형위성 3호 탑재체 '우주용 광시야 대기광 관측 카메라(Republic Of Korea Imaging Test System, 이하 ROKITS)' 과학 임무를 위한 두 번째 과학위원회 워크숍을 개최합니다. ROKIT는 지상 전천카메라 기술을 응용해 90도 화각으로 오로라와 대기광을 관측하는 우주용 카메라로, 오로라가 일어나는 영역인 오로라 타원체의 변화를 가시광(557.7 nm/ 630.0 nm) 영역에서 협대역으로 관측하는 기술을 검증하고, 지구 바깥에서 오는 에너지에 의한 지구 전리권과 고층대기 변화를 연구하고자 합니다. 이번 과학위원회 워크숍에서는 ROKITS와 함께 우주과학 국제협력 프로그램에 관해서도 소개합니다.

- **프로그램**

시간	주제	발표
	10월 25일(화)	
14:00~14:10	환영 인사	
14:10~14:50	ROKITS 개발 현황	이우경 (천문연)
	ROKITS 과학 임무 소개	곽영실 (천문연)
14:50~17:40	ROKITS 과학 임무와 자료 활용 계획	지건화 (극지연) 길효섭 (JHU/APL) 오수연 (전남대) 이영숙 (충남대) Yukinaga Miyashita, 홍준석, 감호식 (천문연)
17:40~18:00	전체 토의	곽영실/김용하 (충남대)
	10월 26일 (수)	
09:30~10:10	ROKITS 시스템/지상 시스템 개발 계획	최성환/백지혜 (천문연)
10:10~11:00	한-미 우주 과학 국제협력	곽영실 (천문연) / 길효섭 (APL)
11:00~11:30	전체 토의	이우경 (천문연)
11:30~11:40	마무리	곽영실 (천문연)

제5회 우주감시분과 워크숍 & 우주감시분과 총회

- **제목:** 우주감시 레이다 개발 기반연구 현황 공유 및 협력 워크숍
- **일시:** 2022년 10월 27일(목) 13:10~15:00
- **장소:** 라마다프라자 제주, 라마다볼륨 Ⅳ
- **모시는 글**

최근 우주개발의 다양화와 우주의 군사적 상업적 이용 증가로 지구궤도상의 우주환경은 급격히 혼잡해지고 있습니다. 더불어 우주물체의 궤도상의 충돌위험과 우주물체의 지구 추락 위험 등 우주로부터의 위험 발생 우려도 계속 증가하고 있습니다. 현재 국내는 우주물체를 감시하는 장비로 우주물체광학감시네트워크(OWL-Net)을 활용하고 있으나, 주야, 날씨의 영향 등으로 우주물체 상시 감시에는 한계를 가지고 있고, 해외 공개된 자료에 의존한 추적 감시만 가능한 상황입니다. 이에 국내에서도 미지의 다중 우주물체에 대한 탐지 능력 확보와 독자적인 우주감시정보 획득을 위한 우주감시 레이다의 필요성이 강조되고 있어, 이를 구축하기 위한 연구가 다각도로 진행되고 있습니다.

이번 워크숍에서는 한국항공우주학회 우주정보연구회 지원으로 진행된 우주감시 레이다 개발 기반 연구의 분석 현황을 우주과학회와 공유함으로써 추후 국내 독자개발이 가능한 우주감시 레이다 확보에 활용하여 국가적인 우주감시 대응 역량을 높이는데 기여하고자 합니다. 관심 있는 분들의 많은 참석을 기대합니다.

- **프로그램**

시간	주제	발표
우주감시 레이다 개발 기반연구 현황 공유 및 협력 워크숍		
13:10~13:20	우주감시분과 워크숍 개회 및 우주감시 임무 소개	최은정 (천문연)
13:20~14:40	우주감시레이더의 요구분석과 관련기술 현황	김은희 (세종대)
	효율적인 우주감시를 위한 대형 디지털배열 레이더 설계에 관한 연구	전상미 (LIGNex1)
	우주감시레이다 운용방안 도출	이현재 (한화시스템)
	우주감시 레이다 성능 분석을 통한 시스템 설계 고려사항 분석	임병균 (항우연)
14:40~15:00	우주감시분과 총회	김명진 (천문연)

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

워크숍 주제 발표 초록

[발표 1] 우주감시레이더의 요구분석과 관련기술 현황

김은희(세종대 교수)

최근 인공우주물체의 급속한 증가에 따라 우주자산을 보호하기 위한 감시 시스템의 필요성이 높아지고 있다. 레이더는 광학 센서에 비해 주야간에 상관이 없고, 기상의 영향이 적으며, 거리 측정이 가능하다는 장점을 가지고 있어 우주감시 센서로 사용되고 있으며, 국내에서도 이를 개발하기 위해 박차를 가하고 있다. 본 발표에서는 우주감시레이더를 개발하기 위한 필요한 요구 분석과 관련기술에 관한 현황을 점검해 보고자 한다.

[발표 2] 효율적인 우주감시를 위한 대형 디지털배열 레이더 설계에 관한 연구

전상미(LIGNex1 수석연구원)

우주 물체를 감시하고 추적하기 위한 시스템 개발의 필요성이 커지고 있지만, 현재까지 국내에는 광학장비와 추적 레이더만이 설치되어 있어서 넓은 영역을 탐색할 수 있는 탐색 레이더는 개발되지 않은 상태이다. 우주감시를 위한 탐색 레이더를 개발할 때 기존의 광학장비나 추적 레이더와 다른 점은 탐색/추적에 해당하는 빔 송신 시간을 자율적으로 할당한다는 점이다. 수백 km 이상의 장거리 소형 표적을 탐지하기 위해서 안테나의 크기와 출력은 증가하는데, 이는 우주물체의 분포와 확률을 고려하여 탐지범위와 목표성능을 어떻게 설정하느냐에 따라 효율적으로 설계할 수 있다. 본 발표에서는 탐지범위 및 목표성능 설정 시 기준이 되는 안테나의 크기 및 출력을 제시하여 탐색 범위에 따른 효용과 비용 측면을 비교할 수 있도록 하며, 설정된 안테나를 개발하여 운용 시 빠르게 이동하는 표적을 효율적으로 탐색할 수 있는 빔 운용 방안에 대해서 논의한다.

[발표 3] 우주감시레이다 운용방안 도출

이현재(한화시스템 전문연구원)

최근 민간 주도의 항공우주산업이 발전하면서 저궤도 영역의 국내/외 우주자산이 급격하게 증가하고 있다. 이로 인한 우주물체 간 충돌 및 추락에 의한 물리적 위협도 증가하는 추세다. 이러한 물리적 위협을 최소화하고 국내 우주자산을 보호하기 위해 항시 우주물체의 감시/정찰이 가능한 우주감시레이다 개발의 필요성이 증대되고 있다. 본 발표에서는 우주감시레이다의 주요 감시/정찰 대상에 대해 설명하고, 우주자산 보호와 미확인 우주물체에 대응하기 위한 우주감시레이다의 운용방안(모드)에 대해 설명하고자 한다.

[발표 4] 우주감시 레이다 성능 분석을 통한 시스템 설계 고려사항 분석

임병균(항공우주연구원 선임연구원)

본격적인 우주시대가 도래함에 따라 독자적인 우주감시 정보 획득 능력 보유에 대한 요구가 증대되고 있다. 이에 따라 우주감시 레이다 기술에 대한 확보가 시급한 실정이다. 효과적인 우주감시 레이다의 시스템 설계/개발을 위해서는 무엇보다 우리가 필요한 우주감시 임무에 대한 정의를 명확히 하고 임무 분석을 통해 레이다 요구사항을 도출하는 것이 매우 중요하다. 또한, 제한적인 개발 조건 하에서 향후 확장 가능한 시스템 개발에 대한 고려사항 분석이 필요하다. 본 발표에서는 우주감시 레이다의 기본적인 레이다 성능을 분석하고, 이를 바탕으로 시스템 설계를 위한 핵심 인자를 도출하고, 최종적으로 우주감시 레이다 시스템 설계를 위한 다양한 고려사항에 대해 정리하고자 한다.

구두발표 논문 제목 및 시간표

10월 26일(수)

제1발표장 (Ramada Ballroom I)

14:00 [기조강연]

Army Space Power Development Plan for Leading The National Space Industry

Seung-Min Lee

Policy Office, Republic of Korea Army HQ

14:50 [IS-I]

Satellite Exploration of the Earth's Upper Atmosphere

Hyosub Kil

Johns Hopkins University Applied Physics Laboratory, USA

15:30 [I-1-1]

The Effect of Transition Region on the Chromospheric Umbral Oscillation

Soo-Sang Kang, Jongchul Chae

Seoul National University

15:45 [I-1-2]

A Preliminary Study on Retrieval of Total Electron Content from Ship-Borne GPS Measurements in the Ocean

Dong-Hyo Sohn[1], Byung-Kyu Choi[1], Junseok Hong[1], Yosup Park[2]

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

16:00 [I-1-3]

A Large-Scale, Long-Duration Auroral Spiral during and After the Late Substorm Recovery Phase and the Concurrent Magnetotail Observations

Yukinaga Miyashita[1,2], Motoharu Nowada[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Shandong University, Weihai, China*

16:15 [I-1-4]

Equinoctial Asymmetry during Solar Minima at Low to Mid Latitude

Madeeha Talha[1,2], Nabeel Ahmed[1], M. Ayyaz Ameen[1], Danislav Sapundjiev[3], Ghulam Murtaza[1]

[1]*Pakistan Space and Upper Atmopshere Research Commission (SUPARCO)*
[2]*Korean Astronomy and Space Science Institute (KASI), University of Science and Technology (UST)*
[3]*Royal Institute of Meteorology, Belgium*

16:30 [I-1-5]

Development Regional Ionospheric Total Electron Content Prediction Model Based on Convolution Long Short-Term Memory (ConvLSTM)

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)*

16:45 [I-1-6]

A Steady-State Slow Solar Wind Model with Alfven Wave Turbulence and Micro-Instabilities

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*

17:05 [IS-II]

Hot News on Hot Venus

Yeon Joo Lee

PRC for Climate and Earth Science, Institute for Basic Science

제2발표장 (Ramada Ballroom II)

15:30 [I-2-1]

HTE-STEAM Based Hands-on Education Program for the Stellar Constellation

Ahra Cho, Yong-Ki Kim

Chungbuk National University

15:45 [I-2-2]

An Analysis of the Effectiveness of Creative Education Programs Using AR/VR

Youngjun Seo, Doyoon Han, Yunjeong Son, Younjeong Heo, Hyoungbum Kim

Chungbuk National University

16:00 [I-2-3]

A Study on the Participation Motive of Trainees in the Newspace Leader Training Project

Shin Myeong Kim, Chol Lee

KAIST Satellite Technology Research Center

16:15 [I-2-4]

Development of Woodworking-Dobsonian Telescope and Education Program with the Telescope Assembly

Min Heo, Yonggi Kim, HyoungBum Kim

ChungBuk National Universty

제3발표장 (Ramada Ballroom III)

15:30 [I-3-1]

CAP-W CADU Processing for Preparations of Its ETB Tests

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

Korea Aerospace Research Institute

15:45 [I-3-2]

Introduction of Mission and Operation Concept of CAS500-3 (Compact Advanced Satellite500-3)

Shin-Hye Moon, Young-Cheul Kim, Jin-Gon Bae, Seok-Soo Kim

Korea Aerospace Industries, Ltd.

16:00 [I-3-3]

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

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

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

16:15 [I-3-4]

The PVSAT S-Band Link In-Orbit Performance in Routine Operation Phase

Sangil Ahn[1], Sang Hyun Han[2], Seung Hoon Han[2]

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

16:30 [I-3-5]

Investigating Update Frequency of an On-Orbit Navigation Filter for Relative Navigation to an Uncooperative Target in a GNSS-denied Environment

Dawoon Jung[1,2], Hyungjoo Yoon[1], Yunju Na[1], Kwangyul Baek[1], Seungkeun Kim[2]

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

제4발표장 (Ramada Ballroom IV)

15:30 [I-4-1]

Korean VLBI Network (KVN) Operation Strategy

Taehyun Jung, KVN Team

Korea Astronomy and Space Science Institute

15:45 [I-4-2]

Operation of KMTNet

Chung-Uk Lee, Dong-Joo Lee, Seung-Lee Kim, Dong-Jin Kim, Sang-Mok Cha, Yongseok Lee, Hyunwoo Kang, Sungwook E. Hong, Jae-Woo Kim, Eon-Chang Sung, Seung-Cheol Bang

Korea Astronomy and Space Science Institute

16:00 [I-4-3]

Maintenance of KMTNet

Dong-Joo Lee[1,2], Chung-Uk Lee[1], Seung-Lee Kim[1], Dong-Jin Kim[1], Sang-Mok Cha[1], Yongseok Lee[1], Hyunwoo Kang[1], Jae-Woo Kim[1], Sungwook E. Hong[1]

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

16:15 [I-4-4]

OWL-Net: Optical Wide-field Patrol Network

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

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

16:30 [I-4-5]

KASI GNSS Data Service

Jong-Kyun Chung, Sung-Moon Yoo, Jungho Cho

Korea Astronomy and Space Science Institute

10월 27일(목)

제1발표장 (Ramada Ballroom I)

09:00 [IS-III]

Preparations for Registering Astronomical Observation Logs of Joseon Dynasty in the UNESCO's Memory of the World

Hyung Mok Lee[1,2], Hong-Jin Yang[2,3,4], Youngsil Choi[2,3]

[1]*Seoul National University*
[2]*UNESCO registration Promotion Committee for Seongbyeoncheukhudanja*
[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*

09:40 [II-1-1]

Investigation of Magnetic Field Connectivity Changes in AR 11974 Related to Two Flares and One CME

Sibaek Yi, Gwangson Choe

Kyung Hee University

09:55 [II-1-2]

Thermospheric Winds and Temperatures in Northern High Latitudes under Quiet and Active 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*

10:10 [II-1-3]

PIC Simulation of Heat Flux Instability

Young Gyung Ko, Ensang Lee

School of Space Research, Kyung Hee University

10:25 [II-1-4]

Analysis of Radio Wave Attenuation Using D-RAP Algorithm and Utilization of Domestic Radio Blackout Alert

Jong-Yeon Yun

National Radio Research Agency, Korean Space Weather Center

10:40 [II-1-5]

A Study of Source Region Temperatures of Impulsive SEP Events with Various Kappa Values

Jin-Yi Lee[1], Stephen Kahler[2], Yuan-Kuen Ko[3], John C. Raymond[4]

[1]*Kyung Hee University*
[2]*Air Force Research Laboratory*
[3]*Naval Research Laboratory*
[4]*The Center for Astrophysics | Harvard & Smithsonian*

11:05 [II-1-6]

Space Radiation Effects in the Commercial Electric Components of Satellites in the Super Low Altitude

Hojin Lee[1,2], Jongdae Sohn[1,2], Junga Hwang[1,2], Jaeyoung Kwak[1,2]

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

11:20 [II-1-7]

Shipborne GNSS Scintillation Observation: First Results from ARAON Icebreaker

Junseok Hong[1], Jong-Kyun Chung[1], Woo Kyoung Lee[1,3], Changsup Lee[2]

[1]*Korea Astronomy and Space Science Institute*

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

11:35 [II-1-8]

Statistical Study of Exohiss Wave Occurrence and Characteristics: Dependence on Solar Wind Parameters and AE Index Using Van Allen Probes

Jiwoo Seo, Kyung-Chan Kim

Department of Astronomy and Space Science, Chungbuk National University

11:50 [II-1-9]

Characteristics of Cold Ions Energized by Negative Spacecraft Surface Charging

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

School of Space Research, Kyung Hee University

12:05 [II-1-10]

Construction of Global IGS-3D Electron Density (N_e) Model by Deep Learning

Eun-Young Ji[1], Yong-Jae Moon[1,2], Young-Sil Kwak[3], Kangwoo Yi[1], Jeong-Heon Kim[3]

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

13:10 [III-1-1]

Analysis of Laser Communication Terminals for Satellite Communications

Manseok Uhm, Dongpil Chang, Byoung-Sun Lee

Electronics and Telecommunications Research Institute

13:30 [III-1-2]

Implementation of Space Laser Communication Payload for 16U Cube Satellite and Development of Optical Ground Station

Kihwan Choi, Taehyun Kim, Junghun Kim, Jihye Kim, Sunghee Lee, Jaewon Lee, Changho Shin

CONTEC Co., Ltd

13:50 [III-1-3]

Space Laser Communication: Introduction and Key Technologies

Hyung-Chul Lim, Jong-Uk Park, Mansoo Choi, Sung-Yeol Yu, Ki-Pyoung Sung, Jeong-Yeol Han, Seonghwan Choi

Korea Astronomy and Space Science Institute

14:10 [III-1-4]

Performance of Laser Communication System with Tip-Tilt Compensation in Atmospheric Turbulence Channels

Hyung-Chul Lim, Jong-Uk Park, Mansoo Choi, Sung-Yeol Yu, Ki-Pyoung Sung, Jeong-Yeol Han, Seonghwan Choi

Korea Astronomy and Space Science Institute

16:20 [IS-IV]

Current Status and Future of the Antarctic Research Activity in Korea

Yeadong Kim

President of Scientific Committee on Antarctic Research (SCAR)

제2발표장 (Ramada Ballroom II)

09:40 [II-2-1]

KPLO Spacecraft Bus Initial Activation and Checkout Results

Moon-Jin Jeon, Young Ho Cho

Korea Aerospace Research Institute

09:55 [II-2-2]

DSN Interface Architecture and Support Level for Flight Dynamics Operation of Danuri

Young-Joo Song, Dong-Gyu Kim, SeungBum Hong, Jonghee Bae, Jun Bang

Korea Aerospace Research Institute

10:10 [II-2-3]

Trajectory Correction Maneuver Decision Process for KPLO Operation: Trajectory Point of View

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

Korea Aerospace Research Institute

10:25 [II-2-4]

KPLO OD Performance for TCM-1

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

Korea Aerospace Research Institute

10:40 [II-2-5]

KPLO Trajectory Correction Maneuver #1 Planning and Execution Result from the Viewpoint of Flight Dynamics

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

Korea Aerospace Research Institute

11:05 [II-2-6]

KPLO On-Board Orbit Module Initial In-Orbit Operation and Performance Check

Jo Ryeong Yim

Korea Aerospace Research Institute

11:20 [II-2-7]

The Introduction of KARI-NASA-ETRI Ground Disruption-Tolerant Network (DTN) Validation Test for KPLO Mission

Inkyu-Kim[1], YoungHo-Cho[1], KyungRak-Lee[2], JinHo-Jo[2]

[1]*Korea Aerospace Research Institute*
[2]*Electronic Telecommunication Research Institute*

11:35 [II-2-8]

Delay/Disruption Tolerant Network Payload for Korea Pathfinder Lunar Orbiter

Byoung-Sun Lee[1,2], Jin-Ho Jo[1], Kyung-Rak Lee[1], Sinae Ji[1], Cheol Oh Jeong[1]

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

11:50 [II-2-9]

Search of Cave Network Beneath Impact Melt Pit Area on the Moon Using GRAIL

Ik-Seon Hong, Yu Yi

Chungnam National University

13:10 [III-2-1]

KMAG Performances and Status in the BLT Orbit

Ho Jin[1], Khan-Hyuk Kim[1], Wooin Jo[1], Hyeonhu Park[1], Junhyun Lee[1], Yunho Jang[1], Hyeonji Kang[1], Ian Garrick Bethell[2], Derac Son[3], Hyojeong Lee[4], Eunhyeuk Kim[5]

[1]*School of Space Research, Kyung Hee university*
[2]*Department of Earth and Planetary Sciences, UCSC, USA*
[3]*Sensorpia*
[4]*NARA Space Technology*
[5]*Korea Aerospace Research Institute*

13:25 [III-2-2]

Initial Results from KMAG Observations aboard the Danuri in Solar Wind

Khan-Hyuk Kim[1], Ho Jin[1], Wooin Jo[1], Junhyun Lee[1], Hyeonhu Park[1], Yunho Jang[1], Eunhyeuk Kim[2]

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

13:40 [III-2-3]

KMAG Level 1 Data Processing Test Using Observation Data during BLT Journey

Wooin Jo[1], Ho Jin[1], Khan-Hyuk Kim[1], Hyeonhu Park[1], Junhyun Lee[1], Yunho Jang[1], Hyeonji Kang[1], Eunhyeuk Kim[2], Jo Ryeong Yim[2], Joo Hyeon Kim[2]

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

13:55 [III-2-4]

Plasma Particles Tracing around Reiner Gamma Using Test Particle Simulations

Jong Hoon Lee, Ensang Lee, Jongho Seon

School of Space Research, Kyung Hee University

14:10 [III-2-5]

Operation and Data Processing Plan of the Wide-Angle Polarimetric Camera Onboarded Danuri

Minsup Jeong[1], Sungsoo S. Kim[2], Kilho Baek[2], Young-Jun Choi[1], Chae Kyung Sim[1], Serin Kim[2]

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

14:25 [III-2-6]

Reflectivity of Venus' Dayside Disk during the 2020 Observation Campaign Conducted by Three Spacecraft and Six Telescopes

Yeon Joo Lee[1,2],
and the Venus Dayside Observation Team*

[1]*DLR Institute of Planetary Research, Germany*
[2]*Planetary Atmospheres Group, PRC for Climate and Earth Science, IBS*

제3발표장 (Ramada Ballroom III)

09:40 [II-3-1]

Satellite Constellation Mission Design Using the Falcon 9 Type Ground-Based Reusable Launcher

Keum-Oh Lee, Sujin Choi, Junseong Lee, Daeban Seo, Sunghyuck Im, Keejoo Lee, Jaesung Park

Korea Aerospace Research Institute

09:55 [II-3-2]

Space Polarization Camera and Military Applications of the Polarization Imaging

Seonghwan Choi[1], Gwanghee Jeong[2], Jungwoong Kim[3], Jihun Kim[1], Chanhaeng Lee[1]

[1]*Korea Astronomy and Space Science Institute*
[2]*AntBridge Ltd.*
[3]*I-trix technology Ltd.*

10:10 [II-3-3]

Mission Design and Development Strategy of the Ground-Based Reusable Launcher Using the 35tonf-Class Methalox Engines

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

Korea Aerospace Research Institute

10:25 [II-3-4]

Analysis of Research Trends in Space Policy Using Topic Modeling

Sechan-Song

The Joint Chiefs of Staff

10:40 [II-3-5]

A Study on the Orbital Characteristics of a Navigational Satellites Constellation Consisting of Inclined Geosynchronous and Geostationary Satellites

Bangyeop Kim, Sang-Il Ahn

Korea Aerospace Research Institute

11:05 [II-3-6]

Ionospheric Effects on Global Navigation Service System (GNSS)

Jong-Kyun Chung

Korea Astronomy and Space Science Institute

11:20 [II-3-7]

Satellite Constellation Architecture for New Concept Surveillance and Reconnaissance

Jaejin Lee, Daehee Lee, Junga Hwang

Korea Astronomy and Space Science Institute

11:35 [II-3-8]

Active Removal of Space Debris through the Decay of Our Satellite KITSAT

Kyungin Kang, Yongmin Kim, Junchan Lee, Hyuntae Choi, Imhyu Shin, Yehyun Kim

Satellite Technology Research Center, KAIST

13:10 [III-3-1]

Science Culture Ecosystem Growing with Cooperation

Junga Hwang[1,2]

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

13:25 [III-3-2]

Science Communication for the Future Generation with an Interdisciplinary Approach

Hyun-Ok Kim

Korea Aerospace Research Institute

13:40 [III-3-3]

Exploring Possibilities of a Play as a Scientific Content Platform

Shincheol Kang[1,2]

[1]*Department of Physics Education, Seoul National University*
[2]*Alienlab, Korea*

13:55 [III-3-4]

Why do We write Popular Science Books in the Age of Video Content?

Myung-Hyun Rhee

GALDAR Science Content Group

제4발표장 (Ramada Ballroom IV)

09:40 [II-4-1]

The Propose of Angle Data Mesurement Method Using Laser Tracking System

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

Korea Astronomy and Space Science Institute

09:55 [II-4-2]

Development of Precision Tracking, Identification and Active Response System for Artificial Space Objects

Sangwoong Min, Suseong Jeong, Youngsoo Kim, Junghwan Shin

Hanwha Systems

10:10 [II-4-3]

Preliminary Results of Development, Verification, and Performance Analysis of Orbit Analysis Software for the Next-Generation SLR System

Eunji Lee[1], Dong-Gu Kim[2], Sang-Young Park[2], Sangyeong Park[1]

[1]*Hanwha Systems*
[2]*Yonsei University*

10:25 [II-4-4]

Geostationary Earth Orbit Survey with OWL-Net: Global GEO Belt Monitoring

Jin Choi[1], Myung-Jin Kim[1], Dong-Goo Roh[1], Hong-Suh Yim[1], Gwanghui Jeong[2], Jung Hyun Jo[1], Eung-Jung Choi[1], Jang-Hyun Park[1], Sungki Cho[1]

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

10:40 [II-4-5]

K-M^{2}ONet: The Meteor and Fireball Observation Network System on the Korean Peninsula

Yun Hak Kim, Dong-Goo Roh, Jang-Hyun Park, Sungki Cho, Jung Hyun Jo, Jeong Yoo Hong, Hong-Suh Yim, Mansoo Choi, Myung-Jin Kim, Eun-Jung Choi, Jin Choi, Jiwoong Yu

Korea Astronomy and Space Science Institute

11:05 [II-4-6]

Modeling and Simulation of the Future Orbital Debris Environment Using the Source-Sink Model

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

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

11:20 [II-4-7]

Comparison Space Object Impact & Collision Disaster with Similar Disasters in Framework Act on the Management of Disasters and Safety

Jeong-Yoo Hong, Sung-Ki Cho, Myung-Jin Kim

Korea Astronomy and Space Science Institute

11:35 [II-4-8]

A Simple Idea and a Feasibility Test on Super Wide Field Optical GEO Belt Surveillance

Jung Hyun Jo

Korea Astronomy and Space Science Institute

11:50 [II-4-9]

A Requirement Analysis and Analytical Derivation of Far Range Rendezvous for a Circular Orbit Target

Hanik Kim, Hyochoong Bang

Aerospace Engineering Department, Korea Advanced Institute of Science and Technology (KAIST)

12:05 [II-4-10]

Necessity of Civil-Military Cooperation in Establishing Space Surveillance Radar

Sujin Lee, Seonghwan Choi, Chansik Kim, Jingil Lee

Korea Space Operation Center, ROKAF Headquarter

10월 28일(금)

제1발표장 (Ramada Ballroom I)

09:00 [IS-V]

Development and Journey of Korea Lunar Orbiter 'DANURI'

Dea-Kwan Kim

Korea Aerosapce Research Institute

11:00 [IV-1-1]

EQM Model and Electronics Development of AIPIM, Plasma Instrument of IAMMAP of CAS500-3

Changho Woo[1], Kwangsun Ryu[1], Seunguk Lee[1,2], Jaemin Hwang[1], Jinkyu Kim[1], Wonho Cha[1], Seong-Og Park[1]

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

11:15 [IV-1-2]

Development of Low Earth Orbit Space Radiation Dosimeter onboard the NEXTSat-2 and Its Space Applications

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

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

11:30 [IV-1-3]

Comparison of Dose Rate at an Aviation Altitude through Various Models Including KREAM Based on ICRU Report 84

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Gyeongbok Jo[3]

[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*

11:45 [IV-1-4]

Performance Analysis of Optical Module (Qualification Model) for the CAP-W Payload of CAS-4 Satellite after AIT (Assembly-Integration and Test)

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

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

12:00 [IV-1-5]

Introduction to the Environmental Monitoring Spectrometer for Aircraft Platform

Dai Ho Ko[1], Won-Beom Lee[1], Jinsuk Hong[2], Sun A Shin[3]

[1]*Korea Aerospace Research Institute*
[2]*Hanwha Systems*
[3]*National Institute of Environmental Research*

12:15 [IV-1-6]

Introduction for the Result of "Performance Evaluation (Midterm Evaluation)" in 2018, 2022 of CAS Development Program.

Keun-Woong Shin[1], Lilim Kook[2], Ji-Mo Yang[1], Dong-In Han[1], Eung-Sik Park[1]

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

제2발표장 (Ramada Ballroom II)

11:00 [IV-2-1]

A Study on Asymmetric Space Weathering with an Updated Lunar Crater List

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

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

11:15 [IV-2-2]

An Analysis of Development and Operation Requirements for a Lunar Rover Using Model

Based System Engineering Requirement Diagram

Hanik Kim, Hyochoong Bang

Aerospace Engineering Department, Korea Advanced Institute of Science and Technology (KAIST)

11:30 [IV-2-3]

A Demagnetizing Study of Lunar Impact Crater Using iSALE Simulation

Hyeonhu Park[1], Ian Garrick-Bethell[2], Brandon C Johnson[3], Ho Jin[1]

[1]*School of Space Reseach, Kyung Hee University*
[2]*University of California, Santa Cruz*
[3]*Purdue University*

11:45 [IV-2-4]

Analysis of Fuel-Optimal Impulsive Trajectory Design for Near-Earth Asteroid Exploration under Optical Navigation Constraints

Pureum Kim, Sang-Young Park

Astrodynamics and Control Lab., Yonsei University

12:00 [IV-2-5]

Galerkin Lie Group Variational Integrator for Analyzing Orbit-Attitude Interactions of Asteroid Probes

Jinah Lee, Chandeok Park

Department of Astronomy, Yonsei University

12:15 [IV-2-6]

Enabling Venus Atmospheric Entry Mission Using Domestic Launch Vehicles

Hyeonjun Kim, Sujin Choi, Keejoo Lee, Jaesung Shin, Jaesung Park

Korea Aerospace Research Institute

제3발표장 (Ramada Ballroom III)

11:00 [IV-3-1]

Open New Horizon with L4 Mission

Kyung-Suk Cho[1], Junga Hwang[1], Eun-Kyung Lim[1], Jeong-Yeol Han[1], Seong-Hwan Choi[1], Jungjoon Seough[1], Rok-Soon Kim[1], Young-Soo Kim[1], Jongdae Sohn[1], Jihun Kim[1], Jaejin Lee[1], Young-Deuk Park[1], Yong-Jae Moon[2], Jong-Ho Seon[2], Ho Jin[2], Soojong Pak[2], Dong-Hun Lee[2], Kwangsun Ryu[3], Jaemyung Ahn[3], Kyung-Wook Min[3], Dae-Young Lee[4], Yu Yi[5], Kichang Yoon[6], Sung-Joon Ye[7], Jongchul Chae[7], Sung-Hong Park[8], Insoo Jun[9], Nat Gopalswamy[10], Jeffrey Newmark[10], Nickolos Arge[10]

[1]*Korea Astronomy and Space Science Institute*
[2]*Kyung Hee University*
[3]*Korea Advanced Institute of Science and Technology*
[4]*Chungbuk National University*
[5]*Chungnam National University*
[6]*National Radio Research Agency*
[7]*Seoul National University*
[8]*Stanford University*
[9]*Jet Propulsion Laboratory*
[10]*National Aeronautics and Space Administration*

11:15 [IV-3-2]

In-Situ Experiments for Heliospheric L4 Mission

Junga Hwang[1,2], Kyungsuk Cho[1], En-kyung Lim[1,2], Jeong-Reol Han[1,2], Sunghwan Choi[1], Jeongjoon Seough[1], Roksoon Kim[1], Youngsu Kim[1], Jongdae Shon[1,2]

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

11:30 [IV-3-3]

Open New Horizon with L4 Mission: What We can do with Remote-Sensing Observations at L4

Eun-Kyung Lim, Kyung-Suk Cho, Junga Hwang, Jeong-Yeol Han, Seonghwan Choi, Jungjoon Seough, Rok-Soon Kim, Young-Soo Kim, Jongdae Sohn

Korea Astronomy and Space Science Institute

11:45 [IV-3-4]

Trajectory Analysis to Sun-Earth's Fourth Lagrange Point

Jinsung Lee, Jaemyung Ahn

Korea Advanced Institute of Science and Technology

12:00 [IV-3-5]

Advantage of Solar Energetic Particle Study by Multiple Remote Sensing and *In-Situ* Measurements at L4

Jinhye Park[1], Hyunjin Jeong[2], Yong-Jae Moon[1,2], Eun-Kyung Lim[3]

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

12:15 [IV-3-6]

Advantages of L4 Mission in View of Remote Sensing and Deep Learning Applications

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

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

제4발표장 (Ramada Ballroom IV)

11:00 [IV-4-1]

Performance Improvement Result of 1 m Telescope in Gwacheon National Science Museum

Elijah J. H. Kim[1,2], Dan Gray[3], Young Jun Park[1,2], Dae Young Park[4], Jae Il Cho[4], Ho Jin[2], Il Hoon Kim[1]

[1]*SLLAB, Inc.*
[2]*Kyung Hee University*
[3]*Sidereal Technology*
[4]*Gwacheon National Science Museum*

11:15 [IV-4-2]

A Study on Excavated *Ilseongjeongsiui* Relics

Sang Hyuk Kim[1], Byeong-Hee Mihn[1,2], Yong Sam Lee[3]

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

11:30 [IV-4-3]

Literature Analysis of the Angbuilgu of King Sejong's Era

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

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

11:45 [IV-4-4]

Properties of Astronomical Accounts Recorded in the *Hyeonjong-Dongggung-Ilgi*

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

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

12:00 [IV-4-5]

Reports of Stars, Planets, and Other Astronomical Objects Recorded in the Joseonwangjo-Sillok

Junhyeok Jeon

Basic Science Research Institute, Chungbuk National University

포스터발표 논문 제목

1부 10월 27일(목) 14:50~16:20

▶ 달과 우주 탐사

[P-1] Investigation on Launch Period for Mars Exploration Mission

Sang-Wook Kang, Jae-In Kim, Sung-Soo Jang, Seo-Rim Lee, Yee-Jin Cheon

Korea Aerospace Research Institute

[P-2] Preliminary Ground Test of Thermal Protection System for Atmospheric Re-Entry Vehicle

Dae-Yeong Kim, Gi-Hyuk Choi

Korea Aerospace Research Institute

[P-3] Development of Mission Planning Rules of Korea Pathfinder Lunar Orbiter Deep-Space Ground System

Dong-Gyu Kim[1], Younju Jo[2]

[1]*Korea Aerospace Research Institute*
[2]*HANCOM inSPACE*

[P-4] MOON Based Spectropolarimeter Telescope (MOST)

Ilhoon Kim[1], Sukbum Hong[2], Joohyun Kim[3], Haingja Seo[4], Elijah J. H. Kim[1,5]

[1]*SLLAB, INC.*
[2]*Korean Minjok Leadership Academy*
[3]*Korea Aerospace Research Institute*
[4]*HANCOM inSpace*
[5]*Kyung Hee University*

[P-5] Descent Dataset Generation for the Development of Terrain Relative Navigation Technology

Jae-In Kim

Korea Aerospace Research Institute

[P-6] EDAC Function on PDHU of Danuri

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

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

[P-7] KPLO X-Band Link Budget Analysis for Received Power Level Prediction in Ground Station during BLT and upto the Moon

Sangman Moon, Changkyoon Kim, Hyeon-Cheol Lee

Korea Aerospace Research Institute

[P-8] Trajectory Design System Interface and Architecture for KPLO Operation

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

Korea Aerospace Research Institute

[P-9] Low Energy Plasma and Magnetic Field Variations Observed by Kaguya in the Lunar Wake

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

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

[P-10] Historical Footprints of Schedule Management for the Korea Pathfinder Lunar Orbiter (KPLO) Program in 2022: Focusing on Event Schedules until the KPLO Launch

Jae-Hoon Song

Korea Aerospace Research Institute

[P-11] The Lunar Region Space Frequency Allocation Review Based on SFCG 32-2R4 Recommendation

Sangil Ahn

Korea Aerospace Research Institute

▶ 우주감시

[P-12] Image Collection Planning Test of KOMPSAT-6 Image Reception and Processing Element

Taebong Oh

Korea Aerospace Research Institute

[P-13] Thermal-Vacuum Test Setup for Optical Test of a Large Optical Payload

Su-Young Chang, Hyung-yun Noh,

Youngchun Youk, Eung-Shik Lee

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

[P-14] Modeling a Laser Tomography Adaptive Optics for the Satellite Laser Ranging System

Howoo Chiang[1], Ji-young Jung[1], Yeonggyu Kim[1], Seok Gi Han[2], Seokyoung Ju[2], Jun Ho Lee[2]

[1]*Hanwha Systems*
[2]*Kongju National University*

[P-15] Study on the Design of Large Array Digital Radar for the Efficient Space Situational Awareness

Sang Mi Chon, Hyung-Seok Jin

LIG NEX1

[P-16] Space Traffic Management for Long-Term Sustainability

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

Korea Aerospace Research Institute

[P-17] Concept of Metaverse Platform for Real-Time Space Traffic Management

Youeyun Jung, Jaedong Seong, Saehan Song, Okchul Jung

Korea Aerospace Research Institute

[P-18] Analysis of Laser Tracking Performance of Spinning Disk of SLR System Using High-Power Laser

Cer-Hee Choi, Suseong Jeong

Hanwha Systems

▶ 태양 및 우주환경

[P-19] Improving the Empirical Solar Wind Forecast (ESWF)

D. Milošić[1,2,3], M. Temmer[2], S. G. Heinemann[4], T. Podladchikova[5], A. Veronig[2], B. Vršnak[6]

[1]*Korea Astronomy and Space Science Institute*
[2]*Institute of Physics, University of Graz, Austria*
[3]*University of Science and Technology*
[4]*Max-Planck-Institut fuer Sonnensystemforschung,*
[5]*Skolkovo Institute of Science and Technology*
[6]*Hvar Observatory, Faculty of Geodesy, University of Zagreb, Croatia*

[P-20] Performance Evaluation of the GIM and IRI-2016 in Low Latitudes Using Ground-Based TEC over Vietnam in 2018-2019

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*

[P-21] A Study for Polarization Properties and Relationship with Geomagnetic Storm of PC1 Waves Detected by BOH Magnetometer during Solar Cycle 24

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Jaeheung Park[1,2], Jiwoo Kim[3], Hangpyo 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]*Geophysical Institute, University of Alaska, Fairbanks, AK, USA*

[P-22] Comparison between Observations and Hybrid Simulations: Cold Protons and Helium Ions Energized by EMIC Waves in the Inner Magnetosphere

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

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

[P-23] Multipole Approximation of Solar Surface Magnetic Field and Its Possible Application to the Solar Interior Currents

Bogyeong Kim, Yu Yi

Chungnam National University

[P-24] Measurement of Cosmic Rays and Internal Background Radiations of CLYC and $LaCl_3$

Sunghwan Kim[1], Phan Quoc Vuong[2], Hongju Kim[2], Ukwon Nam[3], Won-Kee Park[3], Young-Jun Choi[3], Sukwon Youn[4], Sung-Joon Ye[4]

[1]*Cheongju University*
[2]*Kyungpook National University*

[3]*Korea Astronomy and Space Science Institute*
[4]*Seoul National University*

[P-25] Quasi-Periodic Variation of Microwave Brightness Variation along a Solar Flare Loop

Sujin Kim[1], Jeongwoo Lee[2]

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

[P-26] Response of European Ionosphere during the First G3 Intense Geomagnetic Storm in 25 Solar Cycle

Jeongheon Kim[1], Young-Sil Kwak[1,2], ChangSub Lee[3], Jae-Wook Lee[1,2], Hosik Kam[1], TaeYong Yang[1], GeonHwa Jee[3], YongHa Kim[4]

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

[P-27] A Potential Mechanism for Banded Chorus Generation

Kyungguk Min

Department of Astronomy and Space Science, Chungnam National University

[P-28] 3D Global MHD Simulation of Uranus's Magnetosphere

Kyung Sun Park

Chungbuk National University, Korea

[P-29] ITU-R Studies on WRC-23 Agenda Items 1.12 and 9.1, Topic a) Associated with Sun and Space Weather Observation

Su-Chan Bong[1], Kichang Yoon[2], Jiwoong Park[2], Hwangjae Rhee[3], Jongmin Park[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*National Radio Research Agency, MSICT*
[3]*SyncTechno*
[4]*Electronics and Telecommunications Research Institute*

[P-30] A Newly Developed MPI-Based Solver for Non-Isotropic Gravitational Field in the Solar Interior

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

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

[P-31] Irregularities of Nighttime Mid-Latitude Topside Ionosphere in Swarm Satellite Data

Hosub Song[1,2], Jaeheung Park[1,3], Jaejin Lee[1], Yu Yi[2]

[1]*Space Science Division, Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy, Space Science and Geology, ChungNam National University (CNU)*
[3]*Department of Astronomy and Space Science, University of Science and Technology (UST)*

[P-32] Origins of Seasonal Variations in Cosmic Ray Intensity Observed by Neutron Monitors

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

[1]*Chonnam National University*
[2]*Chungnam National University*

[P-33] Verification of the Radiation Exposure Estimation Models with Aircraft-Based Dose Measurements

Dong-Hee Lee, Jiyoung Kim

National Meteorological Satellite Center, Korea Meteorological Administration

[P-34] Characteristics of Solar Wind Chemical Composition for SEP Event Associated with GLEs

Jongil Jung[1], Suyeon Oh[2], Yu Yi[1]

[1]*Chungnam National University*
[2]*Chonnam National University*

[P-35] Statistical Analysis of Geomagnetic Storms in Solar Cycle 24

Sejin Cho[1,2], Jung-Min Shin[2], Ji-Moon Cho[3], Dong-hee Kim[3], Ho-Jung Park[2], Dae-Yong Lee[2], Yong-Sik Shin[2,3], Seung-Gyu Hwang[2,4]

[1]*Chungnam National University, Korea*
[2]*Space Weather Team, Republic of Korea Air Force*
[3]*Department of Physics, Yonsei University*
[4]*Department of Physics, POSTECH*

[P-36] Auroral Occurrences with Different Geomagnetic Activities at Jang Bogo Station, Antarctica

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

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

[P-37] Statistical Analysis of Magnetosonic Waves in Plasmaspheric Plumes

Yun-Gi Han, Kyung-Chan Kim

Department of Astronomy and Space Science, Chungbuk National University

[P-38] Investigation of Mesospheric Gravity Wave Sources Over Mt. Bohyeon Observatory (36.2°N, 128.9°E) by Backward Ray-Tracing

Jun-Yeong Hwang[1], Young-Sook Lee[1], Yong Ha Kim[1], In-Sun Song[2], Hosik Kam[3], Young-Sil Kwak[3,4], Tae-Yong Yang[3]

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

▶ 우주기술

[P-39] Analysis of Residual PRNU of GOCI-II Base on On-Ground/In-Orbit Calibration Data

Gmsil Kang, Songyong Cha, Sang-Soon Yong, Jo-Young Min

Korea Aerospace and Research Institute

[P-40] Container Development for the KPLO Launch Site Transportation

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

Korea Aerospace Research Institute

[P-41] KPLO Flight Software State of Health (SOH) Test at the Launch Site

Soo-Yeon Kang

Korea Aerospace Research Institute

[P-42] Tendency Analysis of Control Error for Hand Over Time

Woo Yong Kang

Korea Aerospace Research Institute

[P-43] Characteristics and Direction of Satellite Insurance

Kyung-Jin Kwon

Korea Aerospace Research Institute

[P-44] Attitude Control Data Analysis of the KPLO's Correction Maneuver for the Launch Vehicle Trajectory Dispersions

Jaewook Kwon, Kwangyul Baek, Dawoon Jung, Hanwoong Ahn

Korea Aerospace Research Institute

[P-45] Validation Data Verification Method for Power EGSE

Kyung-Keun Kim[1], Seung-Hwan Park[2]

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

[P-46] Interference Analysis for GPS and S-Band Receiver in Satellite System

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

Korea Aerospace Research Institute

[P-47] Horizontal Positioning Method for Deep Space Exploration

Kiduck Kim

Korea Aerospace Research Institute

[P-48] Research on Imaging Methods to Acquire Wide-Area Images

Dong-Oh Kim, Jun-Yeong Bok

Satellite Ground Station R&D Division, National Satellite Operation and Application Center, Korea Aerospace Research Institute

[P-49] Research on the Design of High-Reliability Electronics Operating in Space Environments

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

SpaceK Inc

[P-50] Introduction to the Process of Verifying the Electrical Interface of Launch Vehicle Facility between Satellite and Electrical Ground Support Equipment

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

[P-51] Analysis of the Effects of Flexible Model on the Controller Based on Thrusters for Low Earth Orbit Satellite

Yong-Bok Kim, Hong-Taek Choi
Korea Aerospace Research Institute

[P-52] Conceptual Design of Mechanical Interface for On-Orbit Servicing of Standard Space Probes

Eui Keun Kim
Korea Aerospace Research Institute

[P-53] GEO-KOMPSAT-2A AMI Image Navigation and Registration Performance and Anomaly Detection for Quality of AMI Images

Junho Kim
National Meteorological Satellite Center (NMSC), Korea Meteorological Administration (KMA)

[P-54] A Time-Efficient Method for End-to-End Test between Ground System and Satellite System

Jin-Hyuck Kim, Jin-Ho Lee
Korea Aerospace Research Institute

[P-55] A Study on Deep Neural Network-Based Techniques for 6DOF Posture Estimation for Known Non-Cooperative Space Objects

Jin-Hyung Kim[1], Hyunho Jeon[2]
[1]*Korea Aerospace Research Institute*
[2]*Agency for Defense Development*

[P-56] Investigation and Review of International Radiation Test Facilities to Expand the Infrastructure for the Development of Space-Grade Electronic Components

Tae Hyo Kim, Woojun Lee, Geun-Young Park
Korea Aerospace Research Institute

[P-57] Case Study for Thermal Control Design of Deep Space Explorers

Hui-Kyung Kim[1,2], Choon-Woo Lee[1]
[1]*Korea Aerospace Research Institute*
[2]*University of Science and Technology*

[P-58] Introduction of Compact Advanced Satellite500-4 (CAS500-4) Critical Design Applied with CAS500 Standard Platform

Jaehwee Doh, Junseong Kim, Jin-Gon Bae, Seok-Soo Kim
Korea Aerospace Industries, Ltd.

[P-59] Database Structure Design for Mass Property Management in Satellite Development Programs

Hong-Youl Moon
Korea Aerospace Research Institute

[P-60] Final Alignment of KPLO FM

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

[P-61] X-Band Antenna Angular Profile Generation and Validation for Low Earth Orbit Satellite

Kyun-Sang Park
Korea Aerospace Research Institute

[P-62] Development of Electric Thruster Simulator for Satellite AIT

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

[P-63] Collocation Capacity of Geostationary Satellites in 128.2 ± 0.1 deg.E Station-Keeping Box

Bong-Kyu Park
Korea Aerospace Research Institute

[P-64] Aliveness Verification of Flight Model Solar Panel with Illumination Test

Sung-Woo Park, Hee-Sung Park, Hyung-Jin Kim

Korea Aerospace Research Institute

[P-65] The Manufacturing of Infrared Heating System for GEO Satellite FM Thermal Vacuum and Balance Test

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

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

[P-66] Design and Implementation of Telecommand Verification Tool for Geostationary Satellite

Su-Hyun Park

Korea Aerospace Research Institute, KARI

[P-67] Pointing Analysis of a Telecommunication Satellite

Jong Seok Park, Keun Joo Park, Hyoung Yoll Jun

GEO-KOPSAT-3 Program Office, KARI

[P-68] Technical Management Plan for the Small Satellite Development

Jong-Oh Park, Yong-Sik Chun

Korea Aerospace Research Institute (KARI)

[P-69] Trend Analysis of Earth Magnetic Filed by Three-Axis-Magnetometer (TAM) on Satellite during Ground Test Period

Jooho Park, Junwon Son, Youngwoong Park

Korea Aerospace Research Institutegy

[P-70] Fault Management Design for Electrical Power Subsystem of the Next Korean SAR Satellite

Hong Won Park

Korea Aerospace Research Institute

[P-71] Changes of Electrical Ground Support Equipment (EGSE) according to the Payload of Low Earth Orbit (LEO) Satellites

SuWan Bang[1], Hyoungho Ko[2]

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

[P-72] Attitude Orbit Control Mode Design for On-Orbit Servicing Satellite

Kwangyul Baek, Yunju Na

Korea Aerospace Research Institude

[P-73] Data Transmission in UDP and Non-IP Methods

Hyun-Chul Baek, Tae-Gun Son, Jae-Hyoung Park, Myung-Shin Lee

Korea Aerospace Research Institute

▶ 지상 및 우주 인프라 운영기술

[P-74] A Comparison between Palau TLM Station Actual Antenna Drive Data and GPS Location Base Angle Data during the KSLV-II Second Launch Mission

Dong-Young Shin

Korea Aerospace Research Institute

[P-75] Current Development Status of SLR Systems Registered in ILRS and Current Status of SLR Stations in Korea

Seok-Min Song[1,2], Mansoo Choi[1], Yu Yi[2]

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

▶ 초소형 위성

[P-76] Development of the Solid State Telescope Instrument for Measuring Electron Microburst Precipitation in the SNIPE Mission

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

Korea Astronomy and Space Science Institute

2부 10월 28일(금) 9:40~11:00

▶ 달과 우주 탐사

[P-77] Preliminary Thermal Design of GrainCams for the Study of the Lunar Dust Characteristics

Dukhang Lee[1], Bongkon Moon[1], Dae-Hee Lee[1], Seonghwan Choi[1], Jihun Kim[1], Minsup Jeong[1], Jehyuck Shin[1], Chae Kyung Sim[1], Seul-Min Baek[1], Young-Jun Choi[1,2]

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

[P-78] Statistical Study of Low Energy Ions Originated from the Dayside of the Moon in the Geomagnetic Tail

Jaehee Lee[1], Khan-hyuk Kim[1], Seul-Min Baek[2], Ho Jin[1]

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

[P-79] Research on Test Facilities for Verifying the Performance of the Lunar Lander

Jong-Won Lee, Chun-Woo Lee

Korea Aerospace Research Institute

[P-80] Spacecraft Magnetic Interference Analysis of KMAG Observations in the Interplanetary Region

Junhyun Lee[1], Ho Jin[1], Khan-Hyuk Kim[1], Hyeonhu Park[1], Wooin Jo[1], Yunho Jang[1], Hyeonji Kang[1], Eunhyeuk Kim[2], Jo Ryeong Lim[2]

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

[P-81] Observation of Asteroid (65803) Didymos Using KASI Facilities in Support of NASA's DART Experiment

Hee-Jae Lee[1], Myung-Jin Kim[1], Hong-Hyu Moon[1], Young-Jun Choi[1,2]

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

[P-82] Study on Surface Heat Transfer to Lunar Rover for Concept Study

Jong Tai Jang, Jin-Won Kim

Korea Aerospace Research Institute

[P-83] KPLO Spacecraft Bus Operation Results for the First Trajectory Correction Maneuver

Moon-Jin Jeon, Young Ho Cho

Korea Aerospace Research Institute

[P-84] Updated Korea Pathfinder Lunar Orbiter External Disturbance Torque Models Based on Cruise Phase Flight Telemetry

Dawoon Jung, Jae Wook Kwon, Han Woong Ahn

Korea Aerospace Research Institute

[P-85] Analysis of Spectral Difference between Crater Floors and Halos

Eunjin Cho[1,2], Chae Kyung Sim[1], Kilho Baek[3], 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*

[P-86] A Monte-Carlo Dispersion Analysis of KPLO Trajectory Correction Maneuvers for Each Launch Opportunity

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

Korea Aerospace Research Institute

▶ 우주응용

[P-87] Effects of Micro-Vibration on MTF Measurement of Electro-Optical Satellite Payload

Shinwook Kim, Youngchun Youk, Eung-Shik Lee

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

[P-88] Design of Image and Header Analyzer for Satellite System Test

Youngsun Kim, Haeng-Pal Heo

Korea Aerospace Research Institute

[P-89] Design of Electrical Ground Support Equipment for the Focal Plane Unit

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

Eung-Shik Lee
Korea Aerospace Research Institute

[P-90] Development Status of Next-Generation Space Atomic Clock

Hwan-Chun Myung, Sung-Soo Jang
Korea Aerospace Research Institute

[P-91] Analysis of the Verification Plan before the Satellite Assembly and Test of the Electro Optic Payload

Jong-Euk Park, Gm Sil Kang, Haeng-Pal Heo
Korea Aerospace Research Institute

[P-92] Typhoon Hinnamnor Eye Tracking Using Optical Flow from Satellite Image

Jinhyung Park
Korea Aerospace Research Institute

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Jeeyeon Yoon, Sang-Gyu Lee, Seonghui Kim
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구두발표 논문 초록

10월 26일(수) 제1발표장 Ramada Ballroom I

기조강연

Chair: 최호성 (육군)

14:00 [기조강연]

Army Space Power Development Plan for Leading The National Space Industry

Seung-Min Lee

Policy Office, Republic of Korea Army HQ

The use of space domain for military operations is a global trend. The Republic of Korea Army intends to contribute to joint operations by implementing a simultaneous defense strategy by utilizing the Army space power.
In particular, space is the Ultimate High Ground that must be secured in order to build the Army Tiger system.
In this paper, I will briefly present the 'Pegasus Project' promoted by ROKA.
Through this project, the ROKA intends to establish an army space power infrastructure system, establish an army space operation execution system, and build joint space operation capability.
And for these purposes, ROKA intends to build the seven capabilities of satellite communication, satellite reconnaissance, satellite navigation, satellite operation, space power projection, space control, and space domain recognition.
In particular, it aims to become the ROKA that can lead the national space industry by establishing a hyper-connected communication satellite system, a tactical reconnaissance satellites and a ground-based reusable launch vehicles.

제1발표장 Ramada Ballroom I

Invited Talk I

Chair: 곽영실 (천문연)

14:50 [IS-I]

Satellite Exploration of the Earth's Upper Atmosphere

Hyosub Kil

Johns Hopkins University Applied Physics Laboratory, USA

As a gateway between the Earth's environment and space, the Earth's upper atmosphere (thermosphere and ionosphere) is the region where the Sun's energy is first deposited into the Earth's environment. This region is also affected by various forces from lower altitudes such as atmospheric tides, hazardous natural phenomena (earthquakes, tropical storms, volcanoes, tornadoes), and man-made events (rocket launches, explosions). Modern society is increasingly dependent upon satellite-based technology. Various space weather phenomena in the upper atmosphere directly impact satellite tracking, communications, and global navigation satellite system utilization. For a century, significant efforts have been made to explore the upper atmosphere using various techniques. Ground-based instruments provide continuous observations of the upper atmosphere at a given location, but these observations are available only at limited locations over continents. Satellite-based experiments provide observations globally, but the observations of a single satellite are only available instantaneously at a given location. NASA's Geospace Dynamics Constellation (GDC), which will be launched in 2028–2029, aims to understand the deposition of external and internal energies into the upper atmosphere and the response of the upper atmosphere using high temporal and spatial resolution data provided by multiple satellites. However, the GDC mission only consists of in situ measurements, and therefore, large data gaps still exist. Remote sensing of the upper atmosphere with wide field-of-view instruments simultaneously with the in situ measurements is essential to achieve the goals and objectives of the GDC mission. The GDC mission will lead upper atmospheric sciences for the next 20–30 years. Korea has resources to support the GDC mission. Ground-based observations by KASI and KOPRI, new research ideas, and development of new missions in connection to the GDC will provide a great opportunity for Korea to participate in the GDC mission and play a leading role in the field of upper atmospheric sciences.

제1발표장 Ramada Ballroom I

I-1 태양 및 우주환경 I

Chair: 이환희 (천문연)

15:30 [I-1-1]

The Effect of Transition Region on the Chromospheric Umbral Oscillation

Soo-Sang Kang, Jongchul Chae

Seoul National University

Umbral oscillation in the solar chromosphere has been studied consistently to understand the physics of the solar atmosphere. Recently photospheric resonator model paid attention to acoustic reflection 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 another reflective layer like the temperature-minimum. An analytical interpretation assuming a linearly propagating acoustic wave in the non-isothermal atmosphere including the transition region is demonstrated. Consequently we found a damping standing wave reflected by the transition region in the chromosphere.

15:45 [I-1-2]

A Preliminary Study on Retrieval of Total Electron Content from Ship-Borne GPS Measurements in the Ocean

Dong-Hyo Sohn[1], Byung-Kyu Choi[1], Junseok Hong[1], Yosup Park[2]

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

The Global Positioning System (GPS) is an effective tool to estimate the signal delay caused by total electron content (TEC) in the ionosphere. TEC data from ground-based GPS receiver network are increasingly being used to characterize the variability of the ionosphere. Unfortunately, however, most GPS stations are installed on land. In contrast, GNSS observations made in the ocean are relatively insufficient. In this study, we estimate TEC using GPS measurements from the research vessel traveling between the mid- and low-latitude regions of the Pacific ocean. To study the GPS TEC variation in the mid-to-low latitude, the campaign was conducted for about one month using a weighing 5,894 tons research vessel 'ISABU' operated by the Korea Institute of Ocean Science and Technology. We derive the ship's position and GPS TEC, and compare the GPS-derived TEC with the global ionospheric model.

16:00 [I-1-3]

A Large-Scale, Long-Duration Auroral Spiral during and After the Late Substorm Recovery Phase and the Concurrent Magnetotail Observations

Yukinaga Miyashita[1,2], Motoharu Nowada[3]

[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology*
[3]*Shandong University, Weihai, China*

Among various types of aurora in the polar regions, auroral spirals are vortex-like auroras that emerge frequently in the nightside auroral oval under different geomagnetic conditions and have different spatial and temporal scales. In spite of frequent occurrence, the magnetospheric source has not been discussed extensively. Here we report that a large-scale (~400 km) auroral spiral emerged in the poleward part of the auroral oval during the late substorm recovery phase, lasting for more than 1 hour. Its equatorial projection may be highly elongated from the middle to near-Earth and distant magnetotail. In the magnetotail, Two Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft observed flow oscillations in or near the equatorial projection of the equatorward spiral arm. These observations suggest that the magnetotail was active in a wide area even during and after the substorm recovery phase.

16:15 [I-1-4]

Equinoctial Asymmetry during Solar Minima at Low to Mid Latitude

Madeeha Talha[1,2], Nabeel Ahmed[1], M. Ayyaz Ameen[1], Danislav Sapundjiev[3], Ghulam Murtaza[1]

[1]*Pakistan Space and Upper Atmopshere Research Commission (SUPARCO)*
[2]*Korean Astronomy and Space Science Institute (KASI), University of Science and Technology (UST)*
[3]*Royal Institute of Meteorology, Belgium*

Equinoctial asymmetry (EA) of F2-layer critical frequency (foF2) during minimum years of solar cycle 22–23 (1996) and 23–24 (2008) has been studied for low and mid latitude stations ranges from 20°N–55°N. Year 2008 provided an opportunity to study this phenomenon in extreme low EUV conditions. Pronounced/reasonable increase in EA strength at low/mid latitudes from 1996 to 2008 indicates role of EUV in EA. In addition to an increase in strength of EA from 1996 to 2008, variation in its strength and sign (positive if Mar Equinox foF2{means} > Sep Equinox foF2{means} and vice versa) with latitude and longitude are also observed during both years. Similar to previous studies, EA is observed in daytime during both years. However at low latitude stations, two peaks of foF2 are also observed at night: the first peak in summer and the second peak in the beginning of the September equinox which shows superposition of semi-annual and annual components. Hourly analysis showed asymmetry (Sep Equinox foF2{means} > Mar Equinox foF2{means}) from sunset to mid-night at low mid to mid latitude. It appears that the Mid latitude Summer Nighttime Anomaly (MSNA) is extending to September equinox with decreasing magnitudes from Summer to Sep equinox. IRI-16 showed EA during daytime only with over- and under-estimation as compared to observed data. Serious discrepancy between observed and IRI-2016 model values especially during deep minimum suggests modification of model for extreme low EUV condition as well as incorporation of parameters related to global wind pattern in the model.

16:30 [I-1-5]

Development Regional Ionospheric Total Electron Content Prediction Model Based on Convolution Long Short-Term Memory (ConvLSTM)

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)*

Total electron content (TEC) from Global Navigation Satellite System (GNSS) stations are essential parameters representing the ionosphere phenomenon. Therefore, it is imperative to predict the TEC accurately, and numerous approaches have been proposed. Artificial intelligence (i.e., neural network, deep learning) has recently been adopted for predicting TEC using GNSS data from one station. However, little has been done to predict a 2-dimensional TEC map in the local domain (regional TEC map) rather than one station. In this study, we develop the model 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 by employing a deep learning technique called Convolution Long Short-Term Memory (ConvLSTM). To investigate the performance, the model is compared with commonly used empirical ionospheric model, IRI-2016.

16:45 [I-1-6]

A Steady-State Slow Solar Wind Model with Alfven Wave Turbulence and Micro-Instabilities

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

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

The proton temperature anisotropy of the solar wind is known to be naturally developed by the Alfven-wave turbulence and the adiabatic expansion, resulting in the excessive perpendicular and parallel temperature anisotropy, respectively. In this study, we develop a one-dimensional solar wind model with low-frequency Alfven-wave turbulence in order to investigate the role of the anisotropy-driven kinetic instabilities on the thermodynamic evolution of the slow solar wind. We also consider the curved magnetic field line to for the slow solar wind. Theoretical results may be helpful for understanding the physical processes relevant to the presence of ion scale waves observed in the vicinity of 10–30 solar radii and 1 AU.

제2발표장 Ramada Ballroom II

I-2 SS: 대중천문

Chair: 김상혁 (천문연)

15:30 [I-2-1]

HTE-STEAM Based Hands-on Education Program for the Stellar Constellation

Ahra Cho, Yong-Ki Kim

Chungbuk National University

HTE-STEAM program is based on the concept of the HTE (Here, There, Everywhere) and STEAM(Science, Technology, Engineering, Arts, Mathematics). It will be effective in astronomy education that deals with large scales in time and space. Night observation, a hands-on method of astronomy, has many limitations such as weather and time in the school setting. STEAM education can be used to develop an astronomical hands-on education program that replaces night observation. Constellations are being taught in the classroom in the form of lectures without practice. Therefore, it is necessary to develop a hands-on education program for stellar constellations to increase the effectiveness of education. This study aims to develop and present HTE-STEAM based hands-on education program for the stellar constellation.

15:45 [I-2-2]

An Analysis of the Effectiveness of Creative Education Programs Using AR/VR

Youngjun Seo, Doyoon Han, Yunjeong Son, Younjeong Heo, Hyoungbum Kim

Chungbuk National University

This study aimed to find out how creative education programs using AR/VR affect student's creative problem-solving skills and class satisfaction. For this purpose, a total of 179 students in 7 classes of the first grade of J High school located in the Chungbuk region were the subjects of this study. The data were analyzed by performing two-dependent samples (t-test) based on the difference between the pre- and post-scores of creative problem-solving ability test, and the value of class satisfaction was analyzed and interpret using descriptive statistics and interview. The results of this study are as follows. First, except for 'execution', 'problem discovery and analysis', 'idea generation', 'execution plan', 'conviction and communication', and 'innovation tendency' showed statistically significant results. Second, in terms of class satisfaction of the creative education program, it was an average of 3.75 and it was difficult for learners to derive creative ideas, outputs, and results through groups within a given time in regular class, but generally showed a positive

response. Therefore, it was confirmed that the creative education program using AR/VR increased student's learning motivation and interest in the process of generation or expanding ideas to solve problems like educational effect of STEAM.

16:00 [I-2-3]

A Study on the Participation Motive of Trainees in the Newspace Leader Training Project

Shin Myeong Kim, Chol Lee

KAIST Satellite Technology Research Center

The purpose of the Newspace Leader Training Project is to train satellite system engineers. Trainees can receive apprenticeship education from experts by participating in system development projects of space development institutes. This study intends to analyze the motivation of trainees who participated in this project. For this purpose, the general background of trainees was analyzed. In addition, for in-depth analysis, trainees' participation motives and responses to goals after completing this project were analyzed. The results of this study will provide good implications for institutions that operate space manpower training projects and policy makers who plan policies in the future.

16:15 [I-2-4]

Development of Woodworking-Dobsonian Telescope and Education Program with the Telescope Assembly

Min Heo, Yonggi Kim, HyoungBum Kim

ChungBuk National Universty

We developed the 'Woodworking Dobsonian Telescope and applied this telescope to the educational programs for Middle school students who are in difficult conditions to practice telescopes. The purpose of our study is to know whether the telescope assembly and practice have a positive effect on understanding the principles of astronomical observation as well as the developed program has a positive effect on students' understanding of diverse astronomical phenomenons and concepts. Some progress of our study will be presented.

제3발표장 Ramada Ballroom III

I-3 우주기술

Chair: 임조령 (항우연)

15:30 [I-3-1]

CAP-W CADU Processing for Preparations of Its ETB Tests

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

Korea Aerospace Research Institute

Compact Advanced Payload with Wide-swath (CAP-W) is the payload of the CAS500-4 satellite, which has been completed its design and will be joined CAS500-4 Electrical Test Bed (ETB) test as a payload from November 2022. This paper explains CAP-W CADU processing results to prepare coming system level tests, ETB Test and FM Test.

15:45 [I-3-2]

Introduction of Mission and Operation Concept of CAS500-3 (Compact Advanced Satellite500-3)

Shin-Hye Moon, Young-Cheul Kim, Jin-Gon Bae, Seok-Soo Kim

Korea Aerospace Industries, Ltd.

CAS500-3 carries out 3 science missions. BCN (BioCabinet) performs cell culture & 3D printing mission to secure the source technology of tissue engineering and regenerative medicine. IAMMAP (Ionospheric Anomaly Monitoring by Magnetometer And Plasma-probe) monitors changes in the ionospheric space environment. ROKITS (Republic of Korea Imaging Test System) is a wide-area auroral and airglow imager to understand the response of ionosphere-thermosphere system to external and internal forcing in high latitudes. In this paper, mission operation concepts of CAS500-3 are introduced briefly. BCN operates independently from the system mode for at least 60 days with self-battery. IAMMAP measures continuously in magnetic fields and plasma. ROKITS observes auroral and airglow when the ground in the direct-down direction is at night. We also describe the satellite's attitude maneuver and power energy balance results to perform these CAS500-3 missions.

16:00 [I-3-3]

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

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

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

The NEONSAT is being manufactured for the purpose of national security and rapid disaster response by developing about 100 kg mass of 11 microsatellites under the supervision

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

16:15 [I-3-4]

The PVSAT S-Band Link In-Orbit Performance in Routine Operation Phase

Sangil Ahn[1], Sang Hyun Han[2], Seung Hoon Han[2]

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

Since the separation of PVSAT from KSLV-II on 21 June 2022, the S-Band TM/TC link has been fully verified with several different configurations. Especially, with full 3-axis spacecraft attitude control, the link performance has been accurately calculated and showed the value in line with what was expected.

For better link performance in routine operation, the S-band on-board antenna will be operated in ground antenna pointing mode or earth center pointing mode. The one of two different on-board antennas will be selected to be operated in one of two modes.

Thos paper shows the link performance value between PVSAT and 7.3 m KARI antenna for several different configuration parameters like on-board antenna to be operated, downlink rate, on-board antenna pointing mode. Value shows the link performace shows Eb/No values more than 20 dB.

16:30 [I-3-5]

Investigating Update Frequency of an On-Orbit Navigation Filter for Relative Navigation to an Uncooperative Target in a GNSS-denied Environment

Dawoon Jung[1,2], Hyungjoo Yoon[1], Yunju Na[1], Kwangyul Baek[1], Seungkeun Kim[2]

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

On-orbit navigation relative to an uncooperative target in a GNSS-denied environment is challenging due to accumulation of IMU integration error. Typically this difficulty is overcome by periodically updating a navigation filter with additional sensor information such as visual, LiDAR, or radar readings. This work investigates the frequency at which such a navigation filter needs to be updated while approaching a target in order to achieve a required final position and velocity accuracy.

제4발표장 Ramada Ballroom IV

I-4 지상 및 우주 인프라 운영기술

Chair: 한정열 (천문연)

15:30 [I-4-1]

Korean VLBI Network (KVN) Operation Strategy

Taehyun Jung, KVN Team

Korea Astronomy and Space Science Institute

The Korean VLBI Network (KVN) consists of three 21 m radio telescopes (KVN Yonsei Radio Observatory, KVN Ulsan Radio Observatory, and KVN Tamna Radio Observatory) installed in Seoul, Ulsan, and Jeju Island operating at millimeter wavelengths. The total amount of KVN operation time is more than 3,000 hours a year. As a core member of the East Asian VLBI Network (EAVN), we operate the correlation center where all data from the EAVN telescopes is collected and correlated at the Korea Astronomy and Space Science Institute (KASI). At the same time, KVN also participates in global VLBI experiments as a member of the Global Millimeter VLBI Array (GMVA) and the European VLBI Network (EVN). In this talk, I will introduce the KVN operation strategy to support various science programs and technical development including the data management produced by the KVN and global VLBI telescopes.

15:45 [I-4-2]

Operation of KMTNet

Chung-Uk Lee, Dong-Joo Lee, Seung-Lee Kim, Dong-Jin Kim, Sang-Mok Cha, Yongseok Lee, Hyunwoo Kang, Sungwook E. Hong, Jae-Woo Kim, Eon-Chang Sung, Seung-Cheol Bang

Korea Astronomy and Space Science Institute

Korea Astronomy and Space Science Institute installed three identical 1.6-m telescopes and 3.4G pixel Mosaic CCD cameras in Chile, South Africa, and Australia. The main scientific topic of the system is detecting exoplanets using the microlensing method. After a 7-year operation of the system, the KMTNet science team is now leading the international microlensing science community. In this talk, We show the current status of

the KMTNet system and plan.

16:00 [I-4-3]
Maintenance of KMTNet

Dong-Joo Lee[1,2], Chung-Uk Lee[1], Seung-Lee Kim[1], Dong-Jin Kim[1], Sang-Mok Cha[1], Yongseok Lee[1], Hyunwoo Kang[1], Jae-Woo Kim[1], Sungwook E. Hong[1]

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

KMTNet (Korea Microlensing Telescope Network) officially started its operation on October 1, 2015. The main characteristic of the KMTNet is that it operates 24/7 using three identical telescopes if weather permits. To maximize the benefit of uninterrupted observation, the KMTNet team does its best for stable operation, although no specific maintenance season is allocated. In particular, immediate response when we meet a problem is complicated since the system is installed overseas (Chile, South Africa, Australia). This talk will show our maintenance know-how and plans to solve maintenance difficulties of overseas observation systems.

16:15 [I-4-4]
OWL-Net: Optical Wide-field Patrol Network

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

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

OWL-Net (Optical Wide-field patroL Network) is the first space situational awareness facility of its kind in South Korea which consists of five identical 0.5 m wide-field telescopes with 4K by 4K CCDs. The five stations are located in Mongolia, Morocco, Israel, United States, and South Korea. They are being operated in fully autonomous mode with the minimum human intervention. The primary objective of OWL-Net is to track Korean domestic satellites. In addition, it can be possible to conduct time-series photometry of bright solar system objects. After the COVID-19 pandemic, the OWL-Net maintenance works were carried out in 2022. We will present the 2022 progress report of the OWL-Net telescopes and also introduce the lesson learned of the operation of the observatory installed overseas.

16:30 [I-4-5]
KASI GNSS Data Service

Jong-Kyun Chung, Sung-Moon Yoo, Jungho Cho

Korea Astronomy and Space Science Institute

The KASI Global Navigation Satellite Service (GNSS) network and International GNSS Service (IGS) Global Data Center (GDC) have been shown the operation rate more than about 99% since 1992 and 2006, respectively. Based on KASI GNSS permanent network, the KASI contributes to monitoring and researches of tectonics deformation and earthquakes in Korea, and ionospheric monitoring, modeling, and analysis. The KASI has been co-worked with industries related with Real Time Kinematic (RTK) service. The KASI IGS GDC collects the worldwide GNSS data of 512 GNSS permanent station and provide 4 million files per year. We will also report the recent status of KASI oversea GNSS station.

제1발표장 Ramada Ballroom I

Invited Talk II

Chair: 김명진 (천문연)

17:05 [IS-II]
Hot News on Hot Venus

Yeon Joo Lee

PRC for Climate and Earth Science, Institute for Basic Science

Recent Venus missions by ESA and JAXA revealed a considerable level of variability in the atmosphere of the planet. For example, there are significant temporal variations of brightness [1], wind speeds [2], cloud morphologies on the day or night side [3], and trace gaseous abundances [4]. While mechanisms behind the reported variations are a subject of further study, one of the possible impact sources may be volcanic activities on the surface. Venus is expected to be geologically active, but the current status and nature are hidden [5]. To detect active volcanoes on the surface, new Venus missions, NASA's VERITAS and ESA's EnVision, will visit the planet. Another NASA mission, DAVINCI+, will study the chemical compositions of the lower atmosphere using its decent probe. There are more plans toward Venus by India (Shukrayaan-1), Russia (VENERA-D), and China, and several concept studies in the USA and Japan. This recent attention towards Venus is somewhat interesting concerning the long break between 1994 and 2006 (NASA's Magellan 1990–1994, and ESA's Venus Express 2006–2014). How come Venus gains the growing attention of international communities? In this talk, I will introduce the recent Venus exploration and what we want to know about the uninhabitable twin sister of Earth.

[1] Lee et al. 2019, AJ, 158, 126.
[2] Khatuntsev et al. 2013, Icar, 226, 140.
[3] Peralta et al. 2020, GRL, 47, e2020GL087221.
[4] Marcq et al. 2020, Icar, 335, 113368.
[5] Ghail et al. 2020.

10월 27일(목) 제1발표장 Ramada Ballroom I

Invited Talk III

Chair: 양홍진 (천문연)

09:00 [IS-III]

Preparations for Registering Astronomical Observation Logs of Joseon Dynasty in the UNESCO's Memory of the World

Hyung Mok Lee[1,2], Hong-Jin Yang[2,3,4], Youngsil Choi[2,3]

[1]*Seoul National University*
[2]*UNESCO registration Promotion Committee for Seongbyeoncheukhudanja*
[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*

Seongbyeoncheukhudanja (Danja for short) is the observation log that recorded the astronomical variable events in Gwansangam during the Joseon Dynasty. Currently, 38 observation logs of three comets remain in Korea. In the log, observation time, position of the comet, length and direction of the tail, etc. were recorded daily along with a picture of the comet's position and shape. One of these records, in April 1759 (35th year of King Yeongjo), was the serious of observations of Halley's Comet. In this talk, we describe the characteristics and scientific values of these logs in view of the history of astronomy. We then introduce the activities and plans to register the existing set of Danja in the UNESCO Memory of the World.

제1발표장 Ramada Ballroom I

II-1 태양 및 우주환경 II

Chair: 이창섭 (극지연)

09:40 [II-1-1]

Investigation of Magnetic Field Connectivity Changes in AR 11974 Related to Two Flares and One CME

Sibaek Yi, Gwangson Choe

Kyung Hee University

Recently, we have put forward a new method for coronal force-free field (FFF) reconstruction using a poloidal-toroidal (PT) representation and have developed a numerical code based on it. Our code can employ a source surface condition at the top boundary, which accommodates an open magnetic flux, mimicking the real upper solar corona. With this code, the magnetic fields of the active region AR 11974, which produced two flares and one coronal mass ejection (CME), have been reconstructed to investigate the field connectivity change responsible for each eruptive event. The two flares are found to occur by magnetic reconnections in quasi-separatrix layers. The areas of a large squashing factor obtained by our numerical solutions well overlap with flare ribbons of the two flares. It is also found that a large flux bundle created by the first flare drives a series of reconnections in nearby fluxes, which eventually culminates in a CME. In a smaller scale, the active region showed a light bridge in a sunspot umbra. Our numerical solution around this area exhibits the magnetic field structure in and near the light bridge.

09:55 [II-1-2]

Thermospheric Winds and Temperatures in Northern High Latitudes under Quiet and Active 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*

Korea Polar Research Institute has been observing high latitude thermosphere winds and temperatures using ground-based Fabry-Perot Interferometers (FPIs) since 2016. As polar thermosphere directly interact with magnetosphere-ionosphere system via the Earth's magnetic field, it is necessary to understand how geomagnetic activities can change physical properties in polar thermosphere. 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. Thermospheric densities derived from SWARM satellites also mainly depends on the geomagnetic activities.

10:10 [II-1-3]

PIC Simulation of Heat Flux Instability

Young Gyung Ko, Ensang Lee

School of Space Research, Kyung Hee University

Plasmas in space often have finte heat flux. The presence of such heat flux can be a free energy source for heat flux instability. In this study, we investigate the development of heat flux instability using the PIC simulations. Particles are composed of hot electrons, cold electrons and background protons. Heat flux is produced by relative drift of hot and cold electrons. Before the heat flux instability is developed, electrostatic instability occurs due to the relative drift of electrons. The heat flux instability produces electromagnetic waves, which significantly modify the distribution function of electrons. The detailed analysis of the dynamics of particles and waves will be presented.

10:25 [II-1-4]

Analysis of Radio Wave Attenuation Using D-RAP Algorithm and Utilization of Domestic Radio Blackout Alert

Jong-Yeon Yun

National Radio Research Agency, Korean Space Weather Center

Radio blackout (Dellinger phenomenon) is an increase in the amount of X-ray inflow caused by a solar flare, resulting in a rapid increase in the electron density in the D layer of the ionosphere. It is expected that many radio blackouts will occur due to frequent solar flare, expecially during the solar maximum ('24–'25). In order to respond to such a space weather disaster, the Korean Space Weather Center (KSWC) is preparing a domestic ionospheric disturbance alert service. In this study, the correlation between the radio wave attenuation and the scale of radio blackouts using the D-RAP algorithm was analyzed through the case of the radio blackouts due to the R alert. If the D-RAP algorithm is used, the scale of the radio blackouts can be calculated in real-time, so it is expected that it will be effective to use.

10:40 [II-1-5]

A Study of Source Region Temperatures of Impulsive SEP Events with Various Kappa Values

Jin-Yi Lee[1], Stephen Kahler[2], Yuan-Kuen Ko[3], John C. Raymond[4]

[1]*Kyung Hee University*
[2]*Air Force Research Laboratory*
[3]*Naval Research Laboratory*
[4]*The Center for Astrophysics | Harvard & Smithsonian*

Impulsive solar energetic particle (SEP) events generate tremendous enhancements in the abundances of ^{3}He and the heaviest elements. The impulsive SEPs are believed to be accelerated in solar jets by a mechanism that causes a mass-to-charge (A/Q) dependence of the elemental abundance. It is important to understand the source region properties since the accelerated particles in the impulsive SEP events could become the seed population that could be reaccelerated by a coronal mass ejection shock, then produce gradual SEP events. The temperatures of the source region of the impulsive SEPs is known to be about 1–3 MK derived by fitting the SEP abundance power-law distribution vs A/Q which depends on the electron temperature. These are consistent with recent studies based on EUV observations in the solar corona. In this work, we examine whether the temperature estimation from the A/Q would differ with various kappa values in a kappa function representing high-energy tails deviating from a Maxwellian velocity distribution. We use the KAPPA package recently upgraded with the CHIANTI 10 atomic database to calculate the averaged charge states of each element, assuming ionization equilibrium. We find that the differences in the A/Q between a Maxwellian and an extreme kappa distribution are only about 10–20%. We fit power-law enhancement of element abundances as a function of their A/Q with various kappa values. Then, we discuss whether the differences, which deviate from a Maxwellian, i.e., thermal, can affect the determination of the source region temperature.

11:05 [II-1-6]

Space Radiation Effects in the Commercial Electric Components of Satellites in the Super Low Altitude

Hojin Lee[1,2], Jongdae Sohn[1,2], Junga Hwang[1,2], Jaeyoung Kwak[1,2]

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

Cosmic radiation consists of galactic cosmic radiation from outside the solar system and solar cosmic radiation from solar activity. Cosmic radiation is a charged particle with high energy and has a great effect on satellites and humans operating in space. In particular, when charged particles pass through the electric components of the satellite, TID and SEE phenomena typically occur. TID creates electron-hole pairs by transforming bound electrons to free electrons as charged particles pass through electric components. This causes performance degradation of electric components. This study analyzed the changes that occur when irradiated with radiation by dividing commercial OBC into full exposure and shielding in the concept of TID. The performance change of OBC was recorded by irradiating electron, gamma, and proton beams, and the material and thickness of the shield were calculated using GEANT4, MCNP 6.2 Monte Carlo simulation. In addition, irradiation facilities

were simulated using MCNP 6.2, and the calculation results were compared and analyzed with the actual irradiation results.

11:20 [II-1-7]

Shipborne GNSS Scintillation Observation: First Results from ARAON Icebreaker

Junseok Hong[1], Jong-Kyun Chung[1], Woo Kyoung Lee[1,3], Changsup Lee[2]

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

This study reports the first results of shipborne Global Navigation Satellite System (GNSS) scintillation observation. GNSS data effectively monitor the ionosphere because it provides a global observation network with 24-hours operation. However, GNSS deos not fully cover the ocean and polar regions because of the limited access to those areas. Therefore, Korea Astronomy and Space Science Institute (KASI) conducts experiments on GNSS data acquisition in the sea by installing GNSS receivers in marine science research vessels. We installed GNSS scintillation receiver in the ARAON icebreaker, which is managed by Korea Polar Research Institute (KOPRI), and collected the data from June 10, 2021 to May 8, 2022. The number of days on on which observations are available is 276. During two expeditions of ARAON icebreaker to the Arctic and Antarctic, we collected the high rate GNSS scintillation observation with 50 Hz temporal resolution from the equator to the polar region. The results show 1) increasing positioning error due to the plasma irregularities and 2) higher occurrence rate of GNSS scintillation in the Arctic than in the Antarctic. To explain the asymmetry of occurrence rate, we analyze both ionospheric observations and the motion sensor of the ARAON icebreaker, which could affect the quality of the GNSS signal.

11:35 [II-1-8]

Statistical Study of Exohiss Wave Occurrence and Characteristics: Dependence on Solar Wind Parameters and AE Index Using Van Allen Probes

Jiwoo Seo, Kyung-Chan Kim

Department of Astronomy and Space Science, Chungbuk National University

Exohiss waves below 0.1 electron cyclotron frequency are structureless whistler-mode emissions typically observed in the plasmatrough. It is suggested that plasmaspheric hiss inside the plasmasphere can propagate into the plasmatrough and evolves into exohiss. In this study, we statistically investigate the dependence of exohiss occurrence and characteristics on hiss occurrence, solar wind parameters, and geomagnetic AE index based on Van Allen Probes observations from the entire mission period (approximately 2012–2019). Statistical results show that the exohiss waves occur mainly on the dayside (6–18 MLT) and the midnight-to-dawn sector (0–6 MLT), with a much higher occurrence on the dayside. The occurrence regions on the dayside coincide with regions of the high occurrence of intense hiss waves inside the plasmasphere. In addition, their occurrence gradually increases up to ~3 hrs after the measurements of hiss waves and shows a clear MLT dependence. Post-noon (12–18 MLT) exohiss usually appear when high-amplitude hiss waves inside the plasmasphere frequently occur, while pre-noon (6–12 MLT) exohiss appear when relatively small-amplitude hiss waves occur. Our findings imply that the occurrence of the dayside exohiss seems to be related to hiss activity. More interestingly, the occurrence rates of exohiss on the dayside show a significant dependence on the interplanetary magnetic field (IMF) BZ. The most occurrence region of exohiss tends to occur more in the post-noon sector than in the pre-noon sector for more intense southward IMF BZ. The AE effect is comparable to that of the IMF BZ effect. Meanwhile, the occurrence regions of exohiss on the nightside are consistent with those of whistler-mode chorus waves, suggesting that the nightside exohiss may have originated from whistler-mode chorus waves.

11:50 [II-1-9]

Characteristics of Cold Ions Energized by Negative Spacecraft Surface Charging

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

School of Space Research, Kyung Hee University

We have studied the statistical properties of cold ions energized by negative spacecraft charging, using Van Allen Probes-A data for 2013–2014. 26 negative spacecraft charging cases with a minimum potential less than −30 V were identified. They were accompanied by a substorm activity. When the spacecraft was negatively charged, the cold ions (H^+, He^+, and O^+) below 1 eV were energized to the same energy level, indicating that the ions are accelerated by the electric field generated by the negative-charging associated electrostatic potential. By comparing ambient electron number density inferred from the frequency of the upper hybrid waves and energized cold ions' densities, we discuss the contribution of proton and individual heavy ion species to the background plasma.

12:05 [II-1-10]

Construction of Global IGS-3D Electron Density (N_e) Model by Deep Learning

Eun-Young Ji[1], Yong-Jae Moon[1,2], Young-Sil Kwak[3],

Kangwoo Yi[1], Jeong-Heon Kim[3]

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

In this study, we construct a global IGS-3D Ne model that generates global 3-D electron density (Ne) from International Global Navigation Satellite Systems (GNSS) Service (IGS) total electron content (TEC) data through deep learning. As a first step towards this, we develop a model to generate a vertical electron density profile from a TEC value using Multi-Layer Perceptron (MLP). In this process, the vertical electron density profiles (100 km–700 km altitude, ~25 km altitude interval) and the corresponding TEC values of the IRI-2016 model from 2001 to 2013 with resolutions of 2 hours in time, 2.5° in latitude, and 5° in longitude are used. We use the IRI vertical density profiles (approximately 4.2 million) from 2001 to 2008 for training, 2009 for validation, and 2010 to 2013 for a test. The next step is to generate global IGS electron density profiles using the global IGS TECs as input data for the model, which is called the global IGS-3D Ne model. We evaluate the IGS-3D Ne model by comparing the electron density profiles from the incoherent scatter radars (ISRs) at three stations (low, middle, and high latitudes) with the IGS-3D Ne model from 2010 to 2013. The evaluation shows that the electron density profiles from the IGS-3D Ne model are closer to the ISR data than those of the IRI model, especially at high latitudes. The IGS-3D Ne model shows that the averaged RMSE values between IGS and ISR electron density profiles are 0.37 log (m–3), 0.22 log (m–3), and 0.34 log (m3) for all test datasets at Jicamarca, Millstone Hill, and EISCAT stations, respectively. These results suggest that our IGS-3D Ne model has sufficient potential to enhance the ability to predict global electron density profiles.

제2발표장 Ramada Ballroom II

II-2 달과 우주탐사: 과학기술 그리고 정책 I

Chair: 김주현 (항우연)

09:40 [II-2-1]

KPLO Spacecraft Bus Initial Activation and Checkout Results

Moon-Jin Jeon, Young Ho Cho

Korea Aerospace Research Institute

KPLO was successfully launched at Aug 5, 2022 by Falcon-9 launch vehicle. After separated from the launch vehicle, KPLO started autonomous initial operation using start-up RTCS. S-band transmitter was turned on and waited for ground contact. Solar arrays were deployed and started power generation. After thruster control was started, the attitude of KPLO was quickly stabilized and the solar arrays point the Sun. After communication link acquired, units for normal operation were activated. KMAG boom and HGA were successfully deployed. Each attitude sensor and actuator is activated and utilized for normal mode operation without any anomaly. After 24 hours from launch, HGA was used for S-band communication and X-band data playback. Every procedure was performed as planned. In this paper, we present bus initial activation and checkout results of KPLO.

09:55 [II-2-2]

DSN Interface Architecture and Support Level for Flight Dynamics Operation of Danuri

Young-Joo Song, Dong-Gyu Kim, SeungBum Hong, Jonghee Bae, Jun Bang

Korea Aerospace Research Institute

Using a SpaceX Falcon 9 rocket, the Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, was launched at 4 Aug. 23:08:48 (UTC) from Cape Canaveral Space Force Station. To date, Danuri has successfully continued its journey to the Moon using Ballistic Lunar Transfer/Weak Stability Boundary (BLT/WSB) trajectory. For a successful flight dynamics operation, such as real-time tracking, orbit determination, maneuver planning to follow the designed reference trajectory, maneuver recovery, etc., it is essential to establish and manage different levels of support and tracking schedule with Deep Space Network (DSN). In this work, joint efforts devoted between Korea Aerospace Research Institute (KARI) and DSN team are summarized for efficient and smooth real-time flight operation of Danuri. Starting from the top-level interface architecture, detailed operation flows, as well as lessons learned from the mission readiness reviews, are treated. Through Danuri's cooperative operation experience with DSN, a more reliable and efficient partnership is expected in preparation for future Korea's deep space exploration mission.

10:10 [II-2-3]

Trajectory Correction Maneuver Decision Process for KPLO Operation: Trajectory Point of View

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

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO, also known as Danuri) uses Weak Stability Boundary/Ballistic Lunar Transfer (WSB/BLT) trajectory to reach the Moon. In order to correct

errors during flight and to make the KPLO follow the reference trajectory, a total of nine trajectory correction maneuvers (TCM) are scheduled during the trans-lunar cruise (TLC) phase. This paper introduces the process to determine whether to perform or skip the upcoming TCM from the perspective of trajectory. Key considerations include delta-V budget, allowable boundary for TCM, min/max delta-V the thruster can produce, etc.

10:25 [II-2-4]
KPLO OD Performance for TCM-1

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

Korea Aerospace Research Institute

KPLO (Korea Pathfiner Lunar Orbiter) was launched at 4 Aug 2022 23:08:48 UTCG from Cape Canavaral, USA, and flies to the Moon along the WSB/BLT trajectory. From Earth to Moon, KPLO has night chances of a trajectory correction maneuver (TCM). Flight dynamics specialists planned TCM-1 at 7 Aug 2022 to correct the trajectory dispersion of launch vehicle. After launch, KMOC (KPLO Mission Operation Center) receives the tracking data from NASA DSN (Deep Space Networks), located in the United States, Spain, and Australia. During the initial acquisition phase, DSN provided continuous tracking data after the KPLO bus system preparation. Using tracking data, the flight dynamics specialists processed the OD (orbit determination) to provide the estimated position and velocity, and then performed the maneuver planning of TCM-1 based on the definitive ephemeris from OD process. For KPLO OD, a sequential estimation algorithm is used and the orbit determination performance is evaluated by analyzing the position uncertainty of KPLO. After execution of TCM-1, the flight dynamics specialists estimated the maneuver including delta-V and loss mass through the OD process. Using the definitive ephemeris, the maneuver recovery process was performed to evaluate the executed burn. In this research, KPLO OD performance is analyzed for the maneuver planning and the maneuver recovery of TCM-1.

10:40 [II-2-5]
KPLO Trajectory Correction Maneuver #1 Planning and Execution Result from the Viewpoint of Flight Dynamics

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

Korea Aerospace Research Institute

The first Trajectory Correction Maneuver (TCM) of Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, was designed to clear possible launch errors and check the health of Orbit Maneuver Thruster (OMT). Faster TCM1 execution reduced fuel consumption, but it was scheduled at 48 hours after the launch considering operation timeline. In the real operation, TCM1 was executed to compensate a small error from the launch injection. This work summarizes TCM1 planning activity and analysis activity of TCM1 execution result. Several maneuver planning activities with Orbit Parameter Message (OPM) delivered by SpaceX and results from orbit determination activities were done. After TCM1 execution, maneuver recovery activities followed with results from orbit determination activities. TCM1 was executed as planned, so we cancelled TCM2, which was designed to compensate TCM1 error.

11:05 [II-2-6]
KPLO On-Board Orbit Module Initial In-Orbit Operation and Performance Check

Jo Ryeong Yim

Korea Aerospace Research Institute

This research presents the initial in-orbit operation results and performance verification for KPLO On-board Orbit Module. Korea Pathfinder Lunar Orbiter (KPLO) is the first Korean lunar mission spacecraft. It was successfully launched on Aug. 4th in 2022 (UTC) and is navigating safely in the trans-lunar cruise phase now. The on-board orbit module calculates the orbit position and velocity vectors in real time using polynomial interpolation method with orbit parameters generated in the ground station. Therefore, it requires Orbit Parameter Upload operation from the ground station for normal operation. In the previous research, we introduced the design concept of the onboard orbit module for the lunar orbiter, the development concept and verification test results, and the development concept of the interface data generation between the ground operation systems. The ground operation software for the On-board Orbit Module, Orbit Parameter Upload (OPU) is a functional sub-module in Mission Planning PreProcessor (MPP), which is a module of the Mission Planning Subsystem (MPS). The OPU runs automatically when input data is received from Flight Dynamic Subsystem (FDS) according to a predetermined generation rule in the configuration file and also manually whenever users execute. The spacecraft orbit ephemeris transmitted from the FDS can be either the Earth- centered orbit before Lunar Orbit Insertion (LOI) or the lunar-centered orbit after LOI, and is classified by using E or M in the file name. After launch, the KPLO is currently safely cruising in the trans-lunar orbit. This paper will present the operation status of the initial spacecraft orbit parameter generation logic performed in the trans-lunar cruise phase and the results of initial performance verification.

11:20 [II-2-7]

The Introduction of KARI-NASA-ETRI Ground Disruption-Tolerant Network (DTN) Validation Test for KPLO Mission

Inkyu-Kim[1], YoungHo-Cho[1], KyungRak-Lee[2], JinHo-Jo[2]

[1]*Korea Aerospace Research Institute*
[2]*Electronic Telecommunication Research Institute*

Korea Pathfinder Lunar Orbiter (KPLO) has six instruments to observe the craters and surface on the Moon. KPLO should perform various mission orbiting Moon depend on payload operation scenarios.
The one of them is Disruption Tolerant Network (DTN) payload, that could perform the space internet test with bundle protocol in the space region. The ETRI had developed DTN payload on KPLO and participated on the DTN operation in this program. The important of this mission is doing international cooperation with NASA JPL. NASA has the technology of developing DTN-ION (Interplanetary Overlay Network) software. That will support us to validate the our DTN mission successfully.
This paper shows DTN validation test on the ground with joining ETRI, NASA, and KARI. The DTN test configuration and each node that could be connected with TCP and UDP network are defined.
To satisfy our requirements like message, file, and video stream transfer, we had done the test plan and procedure to tightly validate the DTN test on the ground.
Our test result meets enough message, file, and stream video transfer on end-to-end network. the proposed network concept also have the stable network traffic status.
In the future, we will validate DTN mission when KPLO is orbiting the Moon. and compare to our ground test results.

11:35 [II-2-8]

Delay/Disruption Tolerant Network Payload for Korea Pathfinder Lunar Orbiter

Byoung-Sun Lee[1,2], Jin-Ho Jo[1], Kyung-Rak Lee[1], Sinae Ji[1], Cheol Oh Jeong[1]

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

The Delay/Disruption Tolerant Network Payload (DTNPL) is a space internet device developed by the Electronics and Telecommunications Research Institute (ETRI) of Korea. DTN is a type of interplanetary internet that is designed to handle delays and disconnections that frequently occur when using internet in space. DTN is a method modified to fit the space communication environment by adding Bundle Protocol (BP), a store-and-forward function that is not present in the existing terrestrial internet.
DTN technology is an internationally standardized technology and will become a major means of communication network for the future space exploration.
DTNPL will demonstrate space internet communications technology between the DTN nodes in the KPLO and on the Earth. The technology demonstration includes CCSDS File Delivery Protocol (CFDP), Asynchronous Message Service (AMS), and Bundle Streaming Service (BSS). Network nodes for space internet technology demonstration are located in KPLO, NASA, KARI, and ETRI. The four seasons ETRI campus photos will be used for the demonstration of file delivery. A real-time streaming of K-pop band BTS' 'Dynamite' MV from KPLO is one of the technology demonstration of Bundle Streaming Service.

11:50 [II-2-9]

Search of Cave Network Beneath Impact Melt Pit Area on the Moon Using GRAIL

Ik-Seon Hong, Yu Yi

Chungnam National University

In the future, when humans build their bases on terrestrial planets and their moons, caves will be the safest place for outposts. Small terrain called "impact melt pits" have been discovered on the Moon. We propose that a cave network, akin to an anthill, exists under the impact melt pits discovered on the Moon. We obtained accurate Bouguer gravity by calculating regional crustal density using localized admittance of the study area and detected weak gravity (mass deficit) signals. The analysis of seven regions in our study area revealed a mass deficit in some impact melt pits in four lunar regions (Copernicus, King, Stevinus, and Tycho). We propose a cave network in this region, indicated by the gravity decreasing in the impact melt pits region. Our results can be useful for selecting landing sites for future in situ explorations of lunar caves.

제3발표장 Ramada Ballroom III

II-3 안보 우주

Chair: 최호성 (육군)

09:40 [II-3-1]

Satellite Constellation Mission Design Using the Falcon 9 Type Ground-Based Reusable Launcher

Keum-Oh Lee, Sujin Choi, Junseong Lee, Daeban Seo, Sunghyuck Im, Keejoo Lee,

Jaesung Park
Korea Aerospace Research Institute

SpaceX Falcon 9 leads the global launch market through economic efficiency by reusing the first stage. Existing studies have shown that the 35 tonf-class methalox staged combustion engine is optimized for the geographical limitation of the launch site in Korea, where the launch vehicle is designed having the nine engines in the first stage and one same engine in the second stage like the Falcon 9. In this case, in the expendable mode, a payload of 4.7 tons can be put into the 500 km SSO, and in the reusable mode, a payload of 3 tons can be put into the orbit when the first stage is landing on a drone ship located in the downrange of 870 km. Considering the flight safety area of Okinawa prefecture, Autonomous Spaceport Drone Ship (ASDS) mode of the reusable launcher can not be accommodated, the return-to-launch-site (RTLS) mode is a better way to recover the first stage in Korea. For the RTLS mode, a payload of 2 tons can be put into the low Earth orbit with a competitive price. In this study, satellite constellation mission design similar to Starlink is analyzed by using the proposed ground-based reusable launcher in the RTLS mode, and the multiple satellite stacking and separation method in the payload fairing envelop is introduced.

09:55 [II-3-2]

Space Polarization Camera and Military Applications of the Polarization Imaging

Seonghwan Choi[1], Gwanghee Jeong[2], Jungwoong Kim[3], Jihun Kim[1], Chanhaeng Lee[1]
[1]*Korea Astronomy and Space Science Institute*
[2]*AntBridge Ltd.*
[3]*I-trix technology Ltd.*

When the light propagates, it has not only the characteristics of being divided into colors according to wavelength but also polarization characteristics according to the orientation of the oscillation. Astronomical observations of polarized light began in the middle of the 19th century with observations of the moon and the solar corona. Subsequently, polarization measurement technology has developed closely with advances in observational instruments. Korea Astronomy and Space Science Institute (KASI) has developed a variety of space polarization instruments, and recently developed a platform-based pixelated polarization camera for space. In general, polarization instruments rotate a polarization filter to take differently polarized images, but the pixelated polarization camera is possible to take four different polarized images simultaneously because four different polarization filters are placed for each pixel. Polarization observation can extract information that cannot be easily identified with visible or thermal images. In general, since thermal radiation from artificial objects is partially polarized and thermal radiation from natural objects has almost no polarization properties, additional polarization information can be of great help in distinguishing artificial structures from natural objects. This polarization technology can be used in various applications such as mine detection, surveillance systems, and detections of artificial structures under the surface of the water for military purposes. In this presentation, we will introduce the pixelated polarization camera developed by KASI and talk about the military applications of polarization imaging.

10:10 [II-3-3]

Mission Design and Development Strategy of the Ground-Based Reusable Launcher Using the 35tonf-Class Methalox Engines

Junseong Lee, Keum-Oh Lee, Daeban Seo, Keejoo Lee, Jaesung Park
Korea Aerospace Research Institute

Cost effectiveness and responsiveness of the low Earth orbit satellite constellation for intelligence, surveillance, and reconnaissance missions has been demonstrated by the Falcon 9, so far the only ground-based reusable launcher using multiple Merlin engines. By embracing the SpaceX reusable launcher development program, a new ground-based reusable launcher is proposed, which consists of nine 35tonf-class methalox engines for the booster stage and one vacuum version of the same 35tonf-class methalox engine for the upper stage. The mission design and performance of the expendable and return-to-launch-site (RTLS) modes of the launcher are analyzed by optimizing the fuel consumption under the path constraints of the heat flux and dynamic pressure. The non-recurring and recurring costs of the project is estimated by using the TRANSCOST, and the cost effectiveness of the proposed reusable launcher is introduced in terms of the manufacturing, operation, refurbishment costs.

10:25 [II-3-4]

Analysis of Research Trends in Space Policy Using Topic Modeling

Sechan-Song
The Joint Chiefs of Staff

Recently, the commercialization of space due to the development of space technology has changed human behavior and culture in the space area. So the need for appropriate space policies in each field such as military, social, science, and commerce is increasing. Topic modeling is one of the text mining methods for discovering the structure of corpus and hidden topics in machine learning and natural language processing. In previous studies, it is widely used to search for topics in which research

in a specific field is conducted. In this study, 992 papers from 1985 to 2021 in the international journal 'space policy journal' on space policy were analyzed using topic modeling to present the analysis results of research trends in space policy.

10:40 [II-3-5]

A Study on the Orbital Characteristics of a Navigational Satellites Constellation Consisting of Inclined Geosynchronous and Geostationary Satellites

Bangyeop Kim, Sang-Il Ahn

Korea Aerospace Research Institute

The orbital characteristics and DOP (Dilution of Precision) of a navigation satellite constellation consisting of inclined geosynchronous and standard geostationary satellites were considered. The orbits of navigation satellites in India, Japan, and Korea that are operating or developing this type of navigation satellite constellation were analyzed by simulation. In addition, the orbital arrangement method to obtain the optimal DOP was studied by estimating the DOP variation according to the change of the orbital elements of the satellites and the number of satellites.

11:05 [II-3-6]

Ionospheric Effects on Global Navigation Service System (GNSS)

Jong-Kyun Chung

Korea Astronomy and Space Science Institute

The ionosphere between 50 km and ~1,000 km is a ionized layer of the Earth's atmosphere by the solar X-ray/EUV (Extreme Ultraviolet) radiation. The ionospheric electron densities are varied with solar and geomagnetic activities, and have the local time, hourly, daily, monthly, and yearly characteristics according to the latitudes. The ionospheric electron densities make the time delay of GNSS propagation signals between satellites and receivers. GNSS ionospheric delay can be measured by Total Electron Content (TEC). The ionospheric fluctuation of electron densities triggered by solar and geomagnetic storms can affect amplitude and phase scintillation of GNSS signals. The ionospheric delay and scintillation will cause the position errors of the GNSS. In this presentation, the ionospheric effects on GNSS together with GNSS ionospheric models will be reviewed.

11:20 [II-3-7]

Satellite Constellation Architecture for New Concept Surveillance and Reconnaissance

Jaejin Lee, Daehee Lee, Junga Hwang

Korea Astronomy and Space Science Institute

This presentation introduces new concepts in surveillance and reconnaissance satellite architecture. In order to monitor the military activities of enemy countries, optical image acquisition over a wide area has been required. A single satellite can acquire images about 10 km wide, while a Transporter Erector Launcher (TEL) can easily leave the imager's view angle. A military response is only possible when imaging over a sufficiently large area from time to time. This means surveillance and reconnaissance activities require multiple satellites rather than a single satellite. Assuming the image swath is 15 km and the satellites have sunsychronous orbit, about 160 satellites may be required to monitor the entire North Korea everyday. Since medium and large satellites require a huge budget to build such a satellite network, it is necessary to develop a small satellite at as low cost as possible. Hence, we propose a 20 kg CubeSats as a way to design a satellite constellation for these military purposes. This satellite may be equipped with an off-axis optical system to obtain excellent images compared to the same aperture, and it can be used not only for visible light but also for infrared observation. In addition, it is equipped with a thruster that can change the orbit from high altitude to low altitude, so it is possible to acquire high-resolution images even if the size of the satellite is small.

11:35 [II-3-8]

Active Removal of Space Debris through the Decay of Our Satellite KITSAT

Kyungin Kang, Yongmin Kim, Junchan Lee, Hyuntae Choi, Imhyu Shin, Yehyun Kim

Satellite Technology Research Center, KAIST

Rapid increase in space objects as the space industry becomes active today. But the environment in outer space is rapidly deteriorating due to space debris generated by some countries trying to show their ability to destroy space objects to have hegemony in space. Therefore, active action is required. Korea also needs to expand its domestic development capabilities related to the protection of the space environment, such as the safe operation of our satellites, which are space assets, and the removal and reuse of satellites that remain as space debris after the end of the mission. We would like to introduce the return mission by Wooribyul to verify the technology required to derive a new business using active debris removal (ADR) and on-orbit servicing (OOS) technology.

제4발표장 Ramada Ballroom IV

II-4 우주감시

Chair: 최 진 (천문연)

09:40 [II-4-1]

The Propose of Angle Data Mesurement Method Using Laser Tracking System

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

Korea Astronomy and Space Science Institute

As space objects including satellites and space debris increase exponentially in recent years, more precise orbit prediction is required in order to protect the space assets from a catastrophic collision. Currently, orbit prediction of space objects has been executed through its orbit determination using tracking data obtained by radar, electro-optical and laser tracking systems. In this study, we developed the laser tracking system which can also provide angular measurements using a gimbal encoder and analyzed their angular precision. It is expected that the laser tracking system can improve orbit prediction of space debris and plays an important role in space surveillance.

09:55 [II-4-2]

Development of Precision Tracking, Identification and Active Response System for Artificial Space Objects

Sangwoong Min, Suseong Jeong, Youngsoo Kim, Junghwan Shin

Hanwha Systems

As the number of satellites intended for hostile operation and out-of-control space debris increase, active response technologies must be developed in preparation. Hanwha Systems is developing an SLR, AO and Satellite Laser Dazzling system. We will present the current progress towards the implementation of these development projects.

10:10 [II-4-3]

Preliminary Results of Development, Verification, and Performance Analysis of Orbit Analysis Software for the Next-Generation SLR System

Eunji Lee[1], Dong-Gu Kim[2], Sang-Young Park[2], Sangyeong Park[1]

[1]*Hanwha Systems*

[2]*Yonsei University*

Satellite Laser Ranging (SLR) system provides the most accurate ranging data of space objects. For employing the data in space surveillance, precise orbit determination process is required. In this study, a software for orbit determination and prediction using the SLR data is developed. The current version of the software includes precise dynamics model, measurement model, and simple weighted-least squares estimation algorithm. In this study, each model was validated by comparing to the Satellite Tool Kit (STK) and analyzing the actual SLR residual, respectively. The position difference between the ephemeris generated by each software was less than 1 m within 1 day, and the rms of the evaluated residual was 4 cm. Lastly, the orbit determination accuracy was about 100 m for 2 days compared to the reference ephemeris, In the future, we are going to improve the estimation algorithm, determine physical properties of space object, and examine the performance in the operational environment.

10:25 [II-4-4]

Geostationary Earth Orbit Survey with OWL-Net: Global GEO Belt Monitoring

Jin Choi[1], Myung-Jin Kim[1], Dong-Goo Roh[1], Hong-Suh Yim[1], Gwanghui Jeong[2], Jung Hyun Jo[1], Eung-Jung Choi[1], Jang-Hyun Park[1], Sungki Cho[1]

[1]*Korea Astronomy and Space Science Institute*

[2]*antBridge*

The Optical Wide-field patroL-Network (OWL-Net) is global robotic telescope network for observing Korean Low Earth Orbit (LEO) satellites and monitoring Geostationary Earth Orbit (GEO) region as the first Korean Space Situational Awareness (SSA) facility. The four of five stations of the OWL-Net were evenly spaced in the longitudinal direction. With the OWL-Net, the entire GEO belt, except for parts of the Pacific Ocean, can be monitored during local night time. The astrometric position of Space objects on GEO and some objects on GSO can be checked by the GEO surveying for space situational awareness. We presented here test observation and data reduction results for identifying and combining the mosaic images.

10:40 [II-4-5]

K-M^{2}ONet: The Meteor and Fireball Observation Network System on the Korean Peninsula

Yun Hak Kim, Dong-Goo Roh, Jang-Hyun Park, Sungki Cho, Jung Hyun Jo, Jeong Yoo Hong, Hong-Suh Yim, Mansoo Choi, Myung-Jin Kim, Eun-Jung Choi, Jin Choi, Jiwoong Yu

Korea Astronomy and Space Science Institute

As the importance of survaillance of the space objects falling onto the ground increases, not only the safety of people and

their properties but the scientific purposes have become crucial simultaneously. In addition, accordingly, considerable number of countries already have established or are being constructed their own all-sky survaillance systems. Hence, we have established our own all-sky survaillance network system for detecting meteors or fireball events on the Korean peninsula.
Korea Meteor Monitoring and Observation Network (K-M^{2}ONet) is now being operational at 10 observatories and its number is planning to be expanded in the nearer future. The network monitors meteors and fireballs events 24/7 and they also provide the time and the coordinate information of the events. We introduce the coordinate standardization process for each observatories to demonstrate how the meteor coordinates are estimated and, we also show an example of the orbital feature estimation of the meteor such as initial detection location and the approximate altitude at that time.

11:05 [II-4-6]

Modeling and Simulation of the Future Orbital Debris Environment Using the Source-Sink Model

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

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

A rapid expansion of the global space business significantly increases the spatial density of Earth's orbit, increasing the collision risks between space objects, threatening space assets and, ultimately, space environment sustainability. Although under the insufficient space debris mitigation activities in practice, multiple companies are scheduled to launch thousands of satellites in the near future, including mega-constellation satellites such as Starlink, In this research, the space object environment is modeled using the source-sink model. The source-sink model simulates new launches, collisions, and decays using the incoming and outgoing fluxes in the specific orbit regime. A case study is conducted to simulate the future space environment to evaluate the risk in the LEO region, which is considered the most congested.

11:20 [II-4-7]

Comparison Space Object Impact & Collision Disaster with Similar Disasters in Framework Act on the Management of Disasters and Safety

Jeong-Yoo Hong, Sung-Ki Cho, Myung-Jin Kim

Korea Astronomy and Space Science Institute

According to the Framework Act on Disaster and Safety Management, the Ministry of Science and ICT is responsible for handling space object impacts & collisions disasters. However, in reality, there are several problems for the Ministry of Science and ICT to carry out all crisis alert levels and crisis management stages alone. In this regard, we will examine the legal system of similar disasters and look at the direction of improvement.

11:35 [II-4-8]

A Simple Idea and a Feasibility Test on Super Wide Field Optical GEO Belt Surveillance

Jung Hyun Jo

Korea Astronomy and Space Science Institute

We, the center for space situational awareness in Korea Astronomy and Space Science Institute, has developed and been operating several types of telescopes to monitor the artificial satellites and asteroids. Ever since the inarguration of the center, a continuous monitoring system for GEO belt near Korean GEO satellites has been required. In this presentation, author will bring up a simple idea on a single purpose system for GEO belt monitoring and a brief engineering analysis on the system.

11:50 [II-4-9]

A Requirement Analysis and Analytical Derivation of Far Range Rendezvous for a Circular Orbit Target

Hanik Kim, Hyochoong Bang

Aerospace Engineering Department, Korea Advanced Institute of Science and Technology (KAIST)

Rendezvous using Clohessy-Wiltshire equations can be conducted, if the distance between a target and a chaser satellite is relatively small than the distance from the Earth centre to the target. However, this condition requires a time consumption for chaser satellite's orbit transfer to approach a target. In order to avoid the time consumption, far range rendezvous is necessary, and the variables which are removes in Clohessy-Wiltshire equations are derived in the target's LVLH (Local-Vertical-Local- Horizontal) frame. One condition is assumed that the target velocity direction position component in the LVLH of a chaser satellite is 0, and it linearizes the equations with initital position and velocity.

12:05 [II-4-10]

Necessity of Civil-Military Cooperation in Establishing Space Surveillance Radar

Sujin Lee, Seonghwan Choi, Chansik Kim, Jingil Lee

Korea Space Operation Center, ROKAF Headquarter

The competition between nations for preemption in space continues, and as a result, space risks and threats are increasing

day by day. The recent Russia-Ukraine war also showed that space security is national security and is closely related to the space industry. The Air Force is planning Space Odyssey 2050 for space operations and is building space power in stage. The Air Force has been operating Electro-Optical Satellite Surveillance System (EOSS) since January 2022 to acquire space surveillance capabilities. However, its operation is limited due to the influence of weather and observation time. A space surveillance radar system capable of performing all-weather space monitoring needs to be developed jointly with the civilian and military. It takes into account huge financial requirements and business redundancy. A synergy between national security and the space industry can be created through the following: civil-military combined technology development project, space domain awareness using military early warning radar, provision and expansion of information sharing system for space domain awareness with related organization, creation of policy and system conditions, etc.

제1발표장 Ramada Ballroom I

III-1 SS: Space Laser Communication

Chair: 임형철 (천문연)

13:10 [III-1-1]

Analysis of Laser Communication Terminals for Satellite Communications

Manseok Uhm, Dongpil Chang, Byoung-Sun Lee

Electronics and Telecommunications Research Institute

The use of laser communication terminals (LCTs) is increasing for inter-satellite communications due to many advantages. Already equipped v1.5 starlink satellites have been launched and Telesat-LightSpeed LEO satellite with LCTs has been announced. The Space Development Agency (SDA) released the standard about LCTs for Transport Layer constellation. The LCT is the core equipment for the 6G LEO satellite communication systems and relay system of LEO-GEO satellite communications to be developed in Korea. Many foreign companies such as TESAT and Mynaric have already developed many LCTs for satellite payloads, so the technology maturity is high, but we haven't done much research yet. In this paper, we will present the analysis results based on the trend of key technologies of LCTs. Through the analysis, we have a plan to derive specifications of the LCT for the satellite payload to be developed.

13:30 [III-1-2]

Implementation of Space Laser Communication Payload for 16U Cube Satellite and Development of Optical Ground Station

Kihwan Choi, Taehyun Kim, Junghun Kim, Jihye Kim, Sunghee Lee, Jaewon Lee, Changho Shin

CONTEC Co., Ltd

Recently, the demand of high bandwidth transmission link between space to ground has been soaring to satellite communication area. Free space laser communication has advantages for long distance communication by very low signal loss and high bandwidth. For that reason, part of next generation satellites are designed with laser communication transmitter (LCT). CONTEC's first earth observation satellite which will be launched in 2024 integrated with 100 Mbps datarate LCT payload, the first space laser communication demonstration in Korea which transmits enormous size of image sensor data. Also, CONTEC has been developing optical ground stations (OGS) for support of LCT mission.

13:50 [III-1-3]

Space Laser Communication: Introduction and Key Technologies

Hyung-Chul Lim, Jong-Uk Park, Mansoo Choi, Sung-Yeol Yu, Ki-Pyoung Sung, Jeong-Yeol Han, Seonghwan Choi

Korea Astronomy and Space Science Institute

Space laser communication is becoming an attractive alternative to traditional radio frequency communications, due to its higher data rate, license free spectrum, better security and smaller terminals. Recently, many space programs have been planned and launched to develop and demonstrate advanced technologies of space laser communications. Because of the extremely narrow optical bandwidth and atmospheric turbulence, precise beam steering and atmospheric mitigation technologies are required to ensure a reliable and stable laser communication link. In this paper, we will briefly introduce the space laser communication and present key technologies in terms of precise beam steering and atmospheric mitigation.

14:10 [III-1-4]

Performance of Laser Communication System with Tip-Tilt Compensation in Atmospheric Turbulence Channels

Hyung-Chul Lim, Jong-Uk Park, Mansoo Choi, Sung-Yeol Yu, Ki-Pyoung Sung, Jeong-Yeol Han, Seonghwan Choi

Korea Astronomy and Space Science Institute

During the laser beam propagates through turbulent atmosphere,

it experiences beam wandering, scintillation (i.e., intensity fluctuations and phase distortions), and beam spreading. It is considered that the beam wandering is the most significant error source to degrade the performance of laser communication system. The tip-tilt mirror can compensate the angle of arrival caused by the beam wandering. Atmospheric turbulence can be considered as a spatial noise imparing the optical signal. So the adaptive optics (AO) filter function like transverse spectral filters can be applied to remove the spatial noise, which is derived from the Fourier transform of Zernike polynomials. The log-irradiance variances compensated by the tip-tilt mirror is achieved by employing the AO filter funciton. In this study, the performance of bit error rate is analyzed based on the atmospheric turbulence model of log-normal distribution for the pulse position modulation (PPM) link.

제2발표장 Ramada Ballroom II

III-2 달과 우주탐사: 과학기술 그리고 정책 II

Chair: 송영주 (항우연)

13:10 [III-2-1]

KMAG Performances and Status in the BLT Orbit

Ho Jin[1], Khan-Hyuk Kim[1], Wooin Jo[1], Hyeonhu Park[1], Junhyun Lee[1], Yunho Jang[1], Hyeonji Kang[1], Ian Garrick Bethell[2], Derac Son[3], Hyojeong Lee[4], Eunhyeuk Kim[5]

[1]*School of Space Research, Kyung Hee university*
[2]*Department of Earth and Planetary Sciences, UCSC, USA*
[3]*Sensorpia*
[4]*NARA Space Technology*
[5]*Korea Aerospace Research Institute*

The Korean Pathfinder Lunar Orbiter (KPLO), Danuri, was launched to the Moon on August 5, 2022. Danuri will arrive at the moon in the middle of December 2022 after a 4.5-month journey in the BLT orbit.

Danuri has five payloads developed by Kyung Hee University and research institutes, including KARI and one payload from NASA. KMAG is a magnetic field measurement instrument that consists of 3 magnetometers inside a 1.2 meter boom structure. Four hours later, after launch, the KMAG boom was deployed successfully, and then the initial operation started immediately. During operations, the KMAG observed magnetic disturbances passing through the magnetopause and bow shock region and it is also taking observation data in interplanetary magnetic field in space.

The magnetoresistive sensor, which is in the fluxgate control electronics box, also shows magnetic field variance according to Danuri spacecraft activities.

Although there are unexpected new features in the observation data as a first magnetic field observation outside of Earth, we are carrying out data processing using the calibration factors made in consideration of various matters, and the observation data shows reliable results.

13:25 [III-2-2]

Initial Results from KMAG Observations aboard the Danuri in Solar Wind

Khan-Hyuk Kim[1], Ho Jin[1], Wooin Jo[1], Junhyun Lee[1], Hyeonhu Park[1], Yunho Jang[1], Eunhyeuk Kim[2]

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

The Danuri (also known as the Korea Pathfinder Lunar Orbiter, or KPLO) was successfully launched by a SpaceX Falcon 9 rocket on 5 August 2022. In the middle of December this year after ~4.5-month interplanetary travel to the Moon, Danuri will be inserted into a highly elliptical polar orbit circulating the Moon and then reach a stable circular orbit at an altitude of ~100 km on 1 January 2023. The observations of the interplanetary magnetic field and geomagnetic field around the Moon and of the lunar magnetic field aboard Danuri are performed by KMAG consisting of three fluxgate magnetometer sensors on an approximately 1.2 meter long boom. The boom was successfully deployed ~4 hours after launch, and KMAG have observed the magnetic field in space. The KMAG team has corrected the observed magnetic field data to remove time-dependent and/or steady magnetic disturbances originated from the spacecraft body and magnetic sensors mounted on the boom by comparing the interplanetary magnetic field detected by the DSCOVR satellite near the L1 orbit. This paper presents the initial results of the cleaned KMAG data, including the magnetopause and bow shock crossings in the near-Earth space and the interplanetary magnetic field observed in solar wind.

13:40 [III-2-3]

KMAG Level 1 Data Processing Test Using Observation Data during BLT Journey

Wooin Jo[1], Ho Jin[1], Khan-Hyuk Kim[1], Hyeonhu Park[1], Junhyun Lee[1], Yunho Jang[1], Hyeonji Kang[1], Eunhyeuk Kim[2], Jo Ryeong Yim[2], Joo Hyeon Kim[2]

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

The Danuri, which is also known as the Korea Pathfinder Lunar Orbiter (KPLO), was launched on August 5, 2022 (8:08 KST) by a Falcon 9 Block 5 and is cruising the BLT orbit. KMAG,

one of the payloads of KPLO, measures the magnetic field with three fluxgate magnetometers. These sensors are inside a 1.2 meter boom structure which is installed on the top panel (+X) of KPLO. KMAG boom deployment was carried out four hours later after launch. And then, KMAG is taking observation data continuously except special S/C activity periods.

KMAG raw data requires some calibration process to release as public science data. The KMAG data processing level has three major steps. These are Raw, Partially Processed (PP), and Calibrated (CAL). Raw data refer to the level-0 data that is done through binary parsing and data extraction. PP data at level-1 means that a coordinate transformation and attitude correction had been applied from raw data using the SPICE kernels of the KPLO spacecraft, the ancillary data provided by KDGS.

In the last step, the CAL data is calibrated using the temperature effect and ambient field correction. It is defined as level-2 data, i.e., end-user data.

Although it needed the final ancillary data set to do more accurate data processing, we carried out data processing up to PP level with several formulas and SPICE toolkit. Preliminary results show a reliable data conversion process.

13:55 [III-2-4]

Plasma Particles Tracing around Reiner Gamma Using Test Particle Simulations

Jong Hoon Lee, Ensang Lee, Jongho Seon

School of Space Research, Kyung Hee University

The Moon has surface magnetic fields regions, called lunar magnetic anomalies. Lunar swirls are high-albedo features and are colocated with lunar magnetic anomalies. Reiner Gamma is a well-known lunar swirl, which has the strong magnetic field around the lunar surface. In this region, plasma particles can be reflected or deflected by the surface magnetic field. Lunar Space Environment Monitor (LUSEM) will be landed on Reiner Gamma in 2024 through the Commercial Lunar Payload Services (CLPS) program. LUSEM will observe the protons and electrons with energies greater than 50 keV in the magnetotail. However, there have been little studies on the plasmas around the Moon in the magnetotail. In this study, we calculate the trajectories of high-energy plasmas around the Reiner Gamma using test particle simulations. We perform backward-tracing to examine which particles can reach LUSEM considering the field of view of LUSEM. In addition, we examine at what boundary of the simulation domain, the incident particles can reach the LUSEM.

14:10 [III-2-5]

Operation and Data Processing Plan of the Wide-Angle Polarimetric Camera Onboarded Danuri

Minsup Jeong[1], Sungsoo S. Kim[2], Kilho Baek[2], Young-Jun Choi[1], Chae Kyung Sim[1], Serin Kim[2]

[1]*Korea Astronomy and Space Science Institute*

[2]*Kyung Hee University*

Danuri, the first Korean lunar mission orbiter, was successfully launched on August 5, 2022 at Cape Canaverl, USA. It is scheduled to enter the lunar orbit for normal operation in December 2022. PolCam operation team has confirmed that the PolCam works well after the launch campaign. The PolCam will collect polarimetric and photometric data using three passbands. The spatial resolution at the center of the image is 68 m/pixel at 100 km orbit and the polarimetry accuracy is approximately 1%p. We developed the data processing software and procedure with the Integrated System for Imagers and Spectrometers (ISIS) and SPICE Kernels. We present in detail the operation and the data handling procedure.

14:25 [III-2-6]

Reflectivity of Venus' Dayside Disk during the 2020 Observation Campaign Conducted by Three Spacecraft and Six Telescopes

Yeon Joo Lee[1,2], and the Venus Dayside Observation Team*

[1]*DLR Institute of Planetary Research, Germany*

[2]*Planetary Atmospheres Group, PRC for Climate and Earth Science, IBS*

We performed a unique Venus observation campaign to measure the disk brightness of Venus over a broad range of wavelengths in August and September 2020. The primary goal of the campaign is to investigate the absorption properties of the unknown absorber in the clouds. The secondary goal is to extract a disk mean SO2 gas abundance, whose absorption spectral feature is entangled with that of the unknown absorber at the ultraviolet (UV) wavelengths. A total of 3 spacecraft and 6 ground-based telescopes participated in this campaign, covering the 52 to 1,700 nm wavelength range. After careful evaluation of the observational data, we focused on the data sets acquired by 4 facilities. We accomplished our primary goal by analyzing the reflectivity spectrum of the Venus disk over the 283–800 nm wavelengths. Considerable absorption is present in the 350–450 nm range, for which we retrieved the corresponding optical depth by the unknown absorber. The result shows a consistent wavelength dependence of the relative optical depth with that at low latitudes during the Venus flyby by MESSENGER in 2007, which was expected because the overall disk reflectivity is dominated by low latitudes. Last, we summarize the experience obtained during this first campaign that should enable us to accomplish our second goal in future

campaigns.

*Venus Dayside Observation Team: Antonio García Muñoz, Atsushi Yamazaki, Eric Quémerais, Stefano Mottola, Stephan Hellmich, Thomas Granzer, Gilles Bergond, Martin Roth, Eulalia Gallego-Cano, Jean-Yves Chaufray, Rozenn Robidel, Go Murakami, Kei Masunaga, Murat Kaplan, Orhan Erece, Ricardo Hueso, Petr Kabáth, Magdaléna Špoková, Agustín Sánchez-Lavega, Myung-Jin Kim, Valeria Mangano, Kandis-Lea Jessup, Thomas Widemann, Ko-ichiro Sugiyama, Shigeto Watanabe, Manabu Yamada, Takehiko Satoh, Masato Nakamura, Masataka Imai, and Juan Cabrera

제3발표장 Ramada Ballroom III

III-3 SS: 과학문화

Chair: 조중현 (천문연)

13:10 [III-3-1]

Science Culture Ecosystem Growing with Cooperation

Junga Hwang[1,2]

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

These days, interest in science culture or science communication is increasing rapidly. We need to consider that what is important to create an ecosystem that makes science and culture sustainable. It is still unfamiliar to the general public, but what should we do to create a scientific and cultural ecosystem? In this presentation, I would like to share my experiences using broadcasting, media, books, lectures, and academic conferences as a bridge between scientists and the general public.

13:25 [III-3-2]

Science Communication for the Future Generation with an Interdisciplinary Approach

Hyun-Ok Kim

Korea Aerospace Research Institute

Our society has been changing rapidly based on the technology development, so we need to have understanding on science and technology along with the convergent thinking ability. To expand science as a culture particularly for the future generation, science communication can play an important role for bridging the gap between research trends and school curriculum as well as bringing together natural science and liberal arts.
With my book on satellite based earth observation for the general public I have got feedback from various reader groups and the most impressive feedback was from female students at a high school of the liberal arts. In my talk I will share my story as a science communicator and present why I emphasize the message of "new space needs new faces".

13:40 [III-3-3]

Exploring Possibilities of a Play as a Scientific Content Platform

Shincheol Kang[1,2]

[1]*Department of Physics Education, Seoul National University*
[2]*Alienlab, Korea*

Scientific content can be accessed on various media such as YouTube, broadcasting, and books. These platforms are selected according to the producing purpose and target. Content is planned and produced to appropriately utilize the platform. In particular, content produced for the purpose of evoking empathy rather than information delivery is suitable for plays in which actors directly convey emotions through acting in front of the audience.
In this talk, I will share the experience of producing plays: Quantum Warfare and Six months before the Launch. The influence of the play, including the experiences of professional actors, audience reviews, and reactions of scientists and theater groups, will be explored. I will also discuss the possibilities of a play as a scientific content platform.

13:55 [III-3-4]

Why do We write Popular Science Books in the Age of Video Content?

Myung-Hyun Rhee

GALDAR Science Content Group

In this presentation, I will talk about what it means to write a popular science book in an environment where video-based content is the mainstream. I will also talk about the meaning of being the author of science books from the perspective of science communication. I will consider what popular science books to write based on the tentative answers to these questions.

14:50~16:20 1부 포스터 발표

제1발표장 Ramada Ballroom I

Invited Talk IV

Chair: 정종균 (천문연)

16:20 [IS-IV]

Current Status and Future of the Antarctic Research Activity in Korea

Yeadong Kim

President of Scientific Committee on Antarctic Research (SCAR)

Since scientific research began in Antarctica in 1957, areas of research experienced change over time. During the first phase, most studies focused on geophysical studies such as aurora australis, upper atmosphere, and geomagnetism. Gradually, research expanded to include fundamental sciences on the continental geology, glaciology, meteorological observation and life sciences and ecosystems in the Antarctic and the Southern Ocean. In the 1980s, as the ozone depletion over Antarctica was publicized, the importance of Antarctic science as a measure of global environmental change began to emerge. Since then, Antarctica became one of the most important research subjects on global environmental change. In particular, the melting of Antarctic glaciers due to global warming is drawing much attention that causes sea level rise. More recently, acidification of the Southern Ocean and resulting rapid changes in the ecosystem, the reduction of the West Antarctic ice sheet, and changes in the deep ocean currents in Antarctica have become important topics of research.

Korea joined the Antarctic Treaty in 1986 and began its research activities by establishing the King Sejong station on King George Island in 1988. Korea also joined the Scientific Committee on Antarctic Research (SCAR) in 1990 and began to participate in Antarctic society as a full-fledged member. With the establishment of the Korea Polar Research Institute in 2004, the commission of the icebreaking research vessel Araon in 2009, and the construction of the Jang Bogo station in 2014 Korea made a leap forward in Antarctic research.

With the launch of the Araon, the scope of research activities both in terms of its content and location has greatly expanded, and many international collaborative research has been carried out. With the completion of the Jang Bogo station in the western Ross Sea in 2014, Korea focused its research on geophysics, glaciers, and notably upper atmospheric physics at this base while the King Sejong station, located in a relatively lower latitude region, focused its research on ecosystem changes caused by warming. In order to better observe large glaciers situated near the Northern Victoria Land on which the Jang Bogo station is located, a dense observation network was established with unmanned meteorological observing devices, GPS, land and ocean bottom seismometers, and CTD in the surrounding waters to observe the behavior of the glaciers.

Since 2017, the K-Route project is on-going with a goal to establish a third station interior of Antarctica, more than 1,000 km inland from the Jang Bogo station. The planned inland station will be a valuable research laboratory for deep ice drilling, meteorological, astronomical and space observations, and microbiological research in extreme environments. In this light, Korea Polar Research Institute plans to form a research consortium with the Korea Astronomy and Space Science Institute, the Korea Institute of Civil Engineering and Building Technology, and the Korea Railroad Research Institute to establish the inland station. The outcome of the K-Route project and the completion of the Antarctic inland station will be key milestones for Korea moving toward the future of Antarctica.

10월 28일(금) 제1발표장 Ramada Ballroom I

Invited Talk V

Chair: 이 유 (충남대)

09:00 [IS-V]

Development and Journey of Korea Lunar Orbiter 'DANURI'

Dea-Kwan Kim

Korea Aerosapce Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO), or Danuri as a Korean name, is the first Korean lunar probe to carry out five lunar observation missions and one technical validation mission in a circular orbit with an altitude of 100 km from the Moon's surface. Korea Aerospace Research Institute (KARI) started developing the KPLO in 2016 as a cooperative project between KARI, a Korean university and research institutes, and NASA. KPLO consists of a Bus system and six payloads; LUTI (KARI), PolCam (KASI), KGRS (KIGAM), KMAG (KHU), and ShadowCam(NASA). Using Falcon 9 of SpaceX, KPLO was launched in Florida, the USA, on 5 August 2022 and then successfully inserted into the Balistic Lunar Transfer (BLT) orbit, a space path toward the Moon. KARI successfully performed two trajectory correction maneuvers (TCM) and took the Earth-Moon photo using the LUTI camera at 1.24 million km from the Earth. KPLO is on the way to the Moon and will arrive at the lunar mission orbit by the end of this year.

9:40~11:00 2부 포스터 발표

제1발표장 Ramada Ballroom I

IV-1 태양 및 우주환경 III & 우주응용

Chair: 고대호 (항우연)

11:00 [IV-1-1]

EQM Model and Electronics Development of AIPIM, Plasma Instrument of IAMMAP of CAS500-3

Changho Woo[1], Kwangsun Ryu[1], Seunguk Lee[1,2], Jaemin Hwang[1], Jinkyu Kim[1], Wonho Cha[1], Seong-Og Park[1]

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

Advanced Impedance Probe for Ionospheric Monitoring (AIPIM) is a plasma measuring instrument of Ionospheric Anomaly Monitoring by Magnetometer And Plasma Probe (IAMMAP), a scientific payload of the Compact Advanced Satellite 500-3 (CAS500-3) which will be launched in 2024. AIPIM measures plasma electron density of ionosphere for monitoring EIA, one of the ionospheric irregularities. AIPIM consist of two plasma probes: disk type Langmuir Probe (LP) and helical type Impedance Probe(IP). The IP has the advantage of measuring plasma density when ground voltage changes due to the spacecraft charging. Moreover, the superheterodyne circuit in IP increases the observation accuracy. Since it is the first time to develop IP in Korea, LP will be mounted to verify the performance of the IP and to compare the data of two plasma probes in the same environment. EQM model of AIPIM has been developed and this presentation shows an electronic development of AIPIM from the preliminary design and plasma chamber test.

11:15 [IV-1-2]

Development of Low Earth Orbit Space Radiation Dosimeter onboard the NEXTSat-2 and Its Space Applications

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

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

The LEODOS (Low-Earth Orbit Space Radiation Dosimeter) on board the Next Generation small satellite-2 (NEXTSat-2), which is scheduled to be launched in early 2023 by means of the Nuri, KSLV-III, is designed to measure space radiation dose in low-earth orbit. The primary objective of the LEODOS is to map the in-situ space radiation dose by charged particles and neutrons in LEO where most of the preparatory activities for future interplanetary missions are currently taking place. To perform these measurements, the LEODOS is equipped with a particle dosimeter (PD) and a neutron spectrometer (NS). The PD instrument is designed that the 650 um thickness of Si sensor with an effective area of 20 mm × 20 mm is embedded in a 10 mm thickness of tissue-equivalent plastic. This design enables to measure the ambient dose equivalent H*(10) for charged particles, The neutron spectrometer, which consists of a 1.5” Stilbene organic scintillator with a plastic veto detector will measure an equivalent dose for the fast neutrons in the range of 1−10 MeV. The FM of LEODOS mounted on a NEXTSat-2 satellite has completed final thermal/vacuum and vibration tests. The LEODOS is expected to be the unique instrument that provides an accurate and comprehensive measurement of the radiation environment including charged particles and neutrons in the low earth orbit. The main space application of LEODOS will be to the DALO:LVRAD (Lunar Vehicle Radiation Dosimeter) project, (one of proposed instrument for CLPS in Korea) to 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).

11:30 [IV-1-3]

Comparison of Dose Rate at an Aviation Altitude through Various Models Including KREAM Based on ICRU Report 84

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Gyeongbok Jo[3]

[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*

The International Commission on Radiation Units and Measurements (ICRU) report 84 (2010) presents dose rate reference table by cutoff rigidities from 0 to 17 GV for three time periods (January 1998, January 2000, and January 2002) with three majority of commercial flights altitudes (FL310, FL350, and FL390). The data have been widely used for comparison between measurements and model calculations. In this study, we compared ambient dose equivalent rate from four different models of AVIDOS, JISCARD, KREAM and NAIRAS with the ICRU reference data. As a result, JISCARD shows the highest dose rate for all conditions. Dose rates from

AVIDOS is most susceptible for altitude changes, whereas those from NAIRAS is most insensitive for the changes. Difference of dose rate with a cutoff rigidity is the highest in NAIRAS. On the other hands, ICRU reference dose rate shows minimum changes. When it comes to correlation with ICRU reference data, values from JISCARD have most in common with a perspective of correlation coefficient. In terms of χ^2, AVIDOS shows the lowest values based on the reference data.

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

11:45 [IV-1-4]

Performance Analysis of Optical Module (Qualification Model) for the CAP-W Payload of CAS-4 Satellite after AIT (Assembly-Integration and Test)

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

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

Compact Advanced Payload with Wide Swath (CAP-W) is Electro-Optics Camera of the Compact Advanced Satellite-4 (CAS-4) satellite. The CAP-W payload has the 5 multi- spectral channel and capability of wide range of swath width with multi-path stereo imaging by taking a national agriculture, water resource and forest images. The Electro Optical Subsystem (EOS) of CAP-W payload consist of Optical Module (OM) and Camera Electronics Module (CEM). The performance verification of these optical components should be conducted before the Assembly-Integration and Test (AIT) of optical module. In this paper, EOS design of CAP-W payload and the performance verification of mirrors are introduced briefly and then the sequence of AIT is described with related Mechanical Ground Support Equipment (MGSE) and Optical Ground Support Equipment (OGSE). Finally, the result of OM performance is also analyzed.

12:00 [IV-1-5]

Introduction to the Environmental Monitoring Spectrometer for Aircraft Platform

Dai Ho Ko[1], Won-Beom Lee[1], Jinsuk Hong[2], Sun A Shin[3]

[1]*Korea Aerospace Research Institute*
[2]*Hanwha Systems*
[3]*National Institute of Environmental Research*

Environmental Monitoring Spectrometer for Aircraft Platform (EMSA) is under developing by Korea Aerospace Research Institute (KARI). It is a offner type hyper spectral imager with spectral resolution less than a nano-meter. It will fly to monitor atmospheric chemistry precursors of air-pollution under its flight path and its product will be used to support and cross-check of the Geostationary Environment Monitoring Spectrometer (GEMS) on-board the Geo-KOMPSAT-2B. In this presentation, key-requirements, design concept, and integration process of the EMSA are briefly introduced.

12:15 [IV-1-6]

Introduction for the Result of "Performance Evaluation (Midterm Evaluation)" in 2018, 2022 of CAS Development Program.

Keun-Woong Shin[1], Lilim Kook[2], Ji-Mo Yang[1], Dong-In Han[1], Eung-Sik Park[1]

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

"Performance evaluation" consists of 4 stages (R&D planning stage, execution stage, termination stage, and utilization stage). In addition, the evaluation is carried out by the "central administrative agency (government department)" that promotes national R&D projects and the "Science and Technology Innovation Headquarters" that checks and evaluates the performance of the program.

The "Midterm evaluation" as part of "Performance evaluation" evaluates the "achievement of performance goals" and "excellence of performance" on a three-year cycle for programs promoted by government ministries. Each government ministries participating in the program conducts a "self-evaluation" first, and then a "high-level evaluation" is conductend by the "Science and Technology Innovation Headquarters" to check the adequacy of the process/evidence/result.

The results of the "Midterm evaluation" are reflected in the improvement of the evaluation target program and adjustment of the business budget for the next year.

The "Midterm evaluation" of "CAS development program" was conducted twice. the first 'Midterm evaluation' was conducted in 2018 after the start of the "1st stage development program" in 2015.

The 2nd "Midterm evaluation" was conducted in 2022 after the start of the "2nd stage development program" in 2019.

After completing the standard platform design of the CAS Series, the first evaluation conducted in 2018 was "normal" grade. After that, "the CAS system/bus development technology transfer" was completed to the domestic industry in 2020, the launch of CAS-1 was successful in 2021, and the second phase of the program led by the domestic industry was started. As a result, the second Midterm evaluation conducted in 2022, the result was "excellent" grade.

제2발표장 Ramada Ballroom II

IV-2 달과 우주탐사: 과학기술 그리고 정책 III

Chair: 서행자 (인스페이스)

11:00 [IV-2-1]

A Study on Asymmetric Space Weathering with an Updated Lunar Crater List

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

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

The lunar craters are good tools for analyzing asymmetries of space weathering caused by solar wind particles or micro-meteorites. The wall quadrants of a lunar crater provide the advantages of being exposed to space weathering for the same duration and being affected by different fluxes by slope of a crater wall. Previous studies have found latitudinal and longitudinal dependencies of optical properties on the lunar surface. Following Sim et al., who studied the space weathering asymmetry inside lunar craters, we make use of the extended lunar crater database to consider a total of 26,802 craters, ~15 times more numerous craters than the previous study. In the present work, we reproduce the previous results with improved techniques in outer-rim finding, inner-structure defining, and wall-quadrants dividing. Furthermore, we find that northern and southern hemispheres seem not to be symmetrically affected along the ecliptic plane. In our speculation, this result is caused by asymmetric impacts of meteoroids in the northern and southern hemispheres on the Moon.

11:15 [IV-2-2]

An Analysis of Development and Operation Requirements for a Lunar Rover Using Model Based System Engineering Requirement Diagram

Hanik Kim, Hyochoong Bang

Aerospace Engineering Department, Korea Advanced Institute of Science and Technology (KAIST)

The environments of lunar surface are its rotation, thermal, ultraviolet radiation, ionizing radiation, micro meteoroids & space debris, terrain, high vacuum, and lunar dust. The development and operation requirements of a lunar rover have differences to the requirements of Earth around spacecraft. On the one hand, lunar surface ionizing radiation and vacuum environments are same to the around Earth. On the other hand, they have gaps in lunar rotation, thermal transfer, meteoroids & space debris, terrain, and lunar dust. Therefore, the electronics and mechanical components in a lunar rover should satisfy not only the environmental requirements of Earth around spacecraft but also the environmental requirements caused by lunar surface characteristics. In this research, the requirement diagram of Model Based System Engineering (MBSE) is applied using top-down approach to analyze interdependencies between the subsystems of a lunar rover and lunar surface environmental requirements. This analysis is assumed that each subsystem has no constraint for the requirements, and the highest centrality subsystem influenced by the lunar surface environments is searched using Graph theory.

11:30 [IV-2-3]

A Demagnetizing Study of Lunar Impact Crater Using iSALE Simulation

Hyeonhu Park[1], Ian Garrick-Bethell[2], Brandon C Johnson[3], Ho Jin[1]

[1]*School of Space Reseach, Kyung Hee University*
[2]*University of California, Santa Cruz*
[3]*Purdue University*

The Moon does not have a global magnetic field like the Earth, but there is the magnetic anomalies in the Moon's crust. The Moon's anomalies can generally be categorized in four ways: strong isolated anomalies, anomalies within large lunar basins, demagnetized basins, and demagnetized craters (< 300 km-diameter). In this study, we focus on demagnetized craters related to absence of crustal magnetization of impact crater interior. In order to simulate the impact crater formation process, iSALE (impact simplified arbitrary Lagrangian Eulerian)-2D hydrocode was used. iSALE is a multi-material and multi-rheology shock physics code. We obtained simulation results similar to the shape of Chaplygin, Gauss, and Fermi craters with demagnetization state by optimizing the values (e.g. diameter and velocity) of impactor, acoustic fluidization parameters and etc. As a result of the simulation, the distribution of shocked material, the peak shock pressure, and the peak temperature could be derived over time. Based on these results, we present the effect of demagnetization due to impact cratering. Also, we expect further detailed studies of these craters to contribute to basic magnetic models to help test different hypotheses for the magnetization in the craters.

11:45 [IV-2-4]

Analysis of Fuel-Optimal Impulsive Trajectory Design for Near-Earth Asteroid Exploration under Optical Navigation Constraints

Pureum Kim, Sang-Young Park

Astrodynamics and Control Lab., Yonsei University

A preliminary trajectory design for interplanetary missions using high-thrust engines often sets the minimization of fuel use as the main objective of the design. When it comes to missions to small near-Earth asteroids (NEAs), it is often necessary to secure sufficient amount of optical navigation duration before the eventual rendezvous. Fuel-optimal solutions without consideration of this pre-rendezvous optical navigation often results in a transfer trajectory that approaches the target asteroid too rapidly from an arbitrary direction, rendering the use of optical navigation nearly impossible. This issue requires use of braking maneuvers that allows a gentle arrival of the spacecraft at the target asteroid. In this study, we compare unconstrained and optical-navigation-constrained fuel-optimal trajectory solutions to find out that changing the last leg duration can effectively control the fuel use of the constrained transfer trajectory. Further analysis reveals that an ideal extension of this duration can be different for asteroids, possibly due to their geometry. Based on the results, we present an efficient procedure of preliminary trajectory design under optical navigation constraints, which can help trajectory designers to get a quick estimate on the increase in fuel requirement and transfer duration.

12:00 [IV-2-5]

Galerkin Lie Group Variational Integrator for Analyzing Orbit-Attitude Interactions of Asteroid Probes

Jinah Lee, Chandeok Park

Department of Astronomy, Yonsei University

This study addresses Galerkin Lie Group Variation Integrator (GLGVI), a higher-order integrator based on Lie group, for propagating both orbit and attitude trajectories of asteroid probes. It is developed for analyzing orbit-attitude interactions near an asteroid. Compared with the planets, asteroids possess distinct dynamical characteristics; their anisotropic shapes and relatively small masses make it highly difficult to predict translational/rotational motions of asteroid probes, especially in proximity operations; small masses also exaggerate the influence of the orbit-attitude interactions. Numerical simulations reveal that the GLGVI is competitive, among many kinds of integrators, for studying orbit-attitude coupled motions of asteroid probes. This higher-order integrator conserves the total energy when propagating a probe near the Itokowa (25143) for 50 days. It is able to conserve the unity condition of the magnitude of quaternions, whereas ODE45 in Matlab, a conventional, well-known integrator based on Runge-Kutta, is not. The properties of dynamic perturbations such as gravitational harmonics, solar radiation pressure, and the third body effects, and the interactions between orbit and attitude motions are analyzed and illustrated in detail. The interaction becomes greater than typical third-body effects near a planet, as the probe becomes closer to 2.43 km from the center of the Itokawa.

12:15 [IV-2-6]

Enabling Venus Atmospheric Entry Mission Using Domestic Launch Vehicles

Hyeonjun Kim, Sujin Choi, Keejoo Lee, Jaesung Shin, Jaesung Park

Korea Aerospace Research Institute

Our first deep space spacecraft, Danuri (600 kg class spacecraft) was launched on SpaceX's Falcon 9, now on the way to a lunar orbit. In the mean time, an independent access to space has been realized upon the success of the Nuri flight test. There is a great opportunity to deploy a small probe for miniaturized, high-performance scientific payload by this medium-lift launch vehicle. For example, in June '22, the CAPSTONE (25 kg) was sent out for preliminary verification of the orbit (NRHO) to be used in Artemis program on a Rocket Lab's small-lift launch vehicle that can deliver payloads of up to 200 kg into 500 km sun-synchronous orbit. In addition, the company is preparing for a self-funded science mission with atmospheric entry capsule of 20 kg to Venus in 2023 on their high-energy small spacecraft called Photon using its launch vehicle. In the meantime, micro/small satellites for deep space exploration have been mainly launched in the form of rideshare with large launch vehicle, so it has been difficult to secure a target orbit for deep space exploration. However, dedicated launch is possible by using a small-dedicated launch vehicle, making it easy to secure a target orbit for deep space exploration at a reasonable launch cost. The Small Launcher R&D Office in KARI is considering the development of a small launch vehicle that can deliver payloads of up to 500 kg into 500 km sun-synchronous orbit. This launch capability is bigger than Rocket Lab's small launch vehicle. Therefore, the Venus entry mission maybe possible using Nuri and small launch vehicles developing in KARI. In this study, the feasibility of Venus entry mission is examined based on our indigenous launch capability.

제3발표장 Ramada Ballroom III

IV-3 SS: Open New Horizon with L4 Mission

Chair: 최광선 (경희대)

11:00 [IV-3-1]

Open New Horizon with L4 Mission

Kyung-Suk Cho[1], Junga Hwang[1], Eun-Kyung Lim[1],

Jeong-Yeol Han[1], Seong-Hwan Choi[1], Jungjoon Seough[1], Rok-Soon Kim[1], Young-Soo Kim[1], Jongdae Sohn[1], Jihun Kim[1], Jaejin Lee[1], Young-Deuk Park[1], Yong-Jae Moon[2], Jong-Ho Seon[2], Ho Jin[2], Soojong Pak[2], Dong-Hun Lee[2], Kwangsun Ryu[3], Jaemyung Ahn[3], Kyung-Wook Min[3], Dae-Young Lee[4], Yu Yi[5], Kichang Yoon[6], Sung-Joon Ye[7], Jongchul Chae[7], Sung-Hong Park[8], Insoo Jun[9], Nat Gopalswamy[10], Jeffrey Newmark[10], Nickolos Arge[10]

[1]*Korea Astronomy and Space Science Institute*
[2]*Kyung Hee University*
[3]*Korea Advanced Institute of Science and Technology*
[4]*Chungbuk National University*
[5]*Chungnam National University*
[6]*National Radio Research Agency*
[7]*Seoul National University*
[8]*Stanford University*
[9]*Jet Propulsion Laboratory*
[10]*National Aeronautics and Space Administration*

The Sun-Earth Lagrange point L4 is considered as one of the unique places where the solar activity and heliospheric environment can be observed in a continuous and comprehensive manner. The L4 mission affords a clear and wide-angle view of the Sun-Earth line for the study of the Sun-Earth and Sun-Moon connections from remote-sensing observations. In-situ measurements of the solar radiation, solar wind, and heliospheric magnetic field are critical to monitor and forecast the radiation environment for safe human exploration of the Moon and Mars. The L4 mission will significantly contribute advancing heliophysics science, improving the capability of space weather forecasting, and extending space weather studies far beyond near- Earth space. This white paper outlines the importance of L4 observations and advocates comprehensive and coordinated observations of the heliosphere at multi-points including other planned L1 and L5 missions.

11:15 [IV-3-2]

In-Situ Experiments for Heliospheric L4 Mission

Junga Hwang[1,2], Kyungsuk Cho[1], En-kyung Lim[1,2], Jeong-Reol Han[1,2], Sunghwan Choi[1], Jeongjoon Seough[1], Roksoon Kim[1], Youngsu Kim[1], Jongdae Shon[1,2]

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

The Sun-Earth Lagrange point L4 is considered as one of the unique places where the solar activity and heliospheric space radiation environment can be observed in a continuous and comprehensive manner. The heliospheric L4 mission affords a clear and wide-angle view of the Sun-Earth line for the study of the Sun-Earth and Sun-Moon connections in a very stable location. In-situ measurements of the solar radiation, solar wind, and heliospheric magnetic field are critical to monitor and forecast the space radiation environment for safe human exploration of the Moon and Mars. The study of the Sun and Solar activities, which directly affect near-Earth space environment through phenomena such as Corona Mass Ejection (CME) and Solar Energy Particle (SEP), is a key research area where knowledge of the academic domain is applied to space exploration. In this presentation, we will review the field exploration space science installation that has been operated or is scheduled to be operated in deep space areas including Lagrange Points. Through the scientific review of the in-situ payloads, we would like to gauge the possibility of Korea's deep space exploration in L4 and examine the knowledge and technology of the areas that are lacking at current status.

11:30 [IV-3-3]

Open New Horizon with L4 Mission: What We can do with Remote-Sensing Observations at L4

Eun-Kyung Lim, Kyung-Suk Cho, Junga Hwang, Jeong-Yeol Han, Seonghwan Choi, Jungjoon Seough, Rok-Soon Kim, Young-Soo Kim, Jongdae Sohn

Korea Astronomy and Space Science Institute

L4 is one of the Sun-Earth Lagrangian points, which is located 60 deg ahead of Earth's orbit and is known as a meta-stable location along with L5, at 60 deg behind Earth's orbit. Considering the effects of Earth-facing halo CMEs or SEP events on space weather hazards, taking advantage of these two vantage points for space-weather monitoring and advanced forecasting is one of the important goals we should succeed in shortly. Compared to L5, L4 has some advantages in monitoring and forecasting SEP events and their sources, such as flares or CMEs. Source active region of severe SEPs that is magnetically connected to the Earth often locates near the west limb, which cannot be seen from L5. From L4, on the other hand, any pre-eruptive characteristics of source active regions and their atmospheric composition can be investigated in detail with a minimum projection effect. Korean researchers in heliophysics and solar physics recently submitted a white paper on NASA Heliophysics 2024 decadal survey, suggesting our vision and willingness to carry out this vast and vital mission. We review some of the already-suggested international space missions from the viewpoint of remote-sensing observations and want to diagnose our capabilities and directions in remote-sensing solar science.

11:45 [IV-3-4]

Trajectory Analysis to Sun-Earth's Fourth

Lagrange Point

Jinsung Lee, Jaemyung Ahn

Korea Advanced Institute of Science and Technology

Six government-funded research institutes are working together to develop Lunar Infrared Spectrometer (LIRS), Gamma-ray Spectrometer (GRS), Neutron Spectrometer (NS) for future Korean lunar exploration since July of 2015. As a part of the space-core technology project, the goal is to develop the engineering models of them. Currently mechanical and electronic parts of LIRS are ready to assemble, and proto-models for GRS and NS are developed. Main sensors, such as IR sensor and HPGe sensor are delivered and tested. In addition, three instruments are successfully designed to satisfy the required mass, and power budget for spacecraft. In this paper, we will briefly present the current status in development of the instruments and the plan for the next year.

The fourth Lagrange point (L4) is a stable point located 60 degrees ahead of the Earth's orbit about the Sun. L4 is an ideal location for performing heliophysics/spheric observations. When located ideally, the spacecraft would also be able to serve as a observatory that oversees the entire solar radiation hemisphere for protecting the Moon and Mars exploration astronauts from radiation exposure. In this paper, we will summarize the trajectory design procedure for inserting a spacecraft into a stable periodic orbit about L4. Both chemical and electrical propulsion systems were considered and compared to their necessary propellant mass to place a 2,000 kg spacecraft in the desired stable orbit. Inclined periodic orbits for solar pole observation were tested to determine the required inclination about the ecliptic plane.

12:00 [IV-3-5]

Advantage of Solar Energetic Particle Study by Multiple Remote Sensing and *In-Situ* Measurements at L4

Jinhye Park[1], Hyunjin Jeong[2], Yong-Jae Moon[1,2], Eun-Kyung Lim[3]

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

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

[3]*Korea Astronomy and Space Science Institute*

Solar Energetic Particles (SEPs) consist of protons, electrons, and heavy ions with an energy range from a few hundred keV to GeV. They are accelerated in magnetic reconnection regions and by Corona Mass Ejection (CME)-driven shocks. The SEP events are one of the crucial phenomena in terms of space weather. They are likely to have large fluences and can pose serious radiation hazards. In particular, SEPs accelerated in the west and near the west limb can cause rapid and strong flux enhancements to the Earth. The events propagated along with Parker spiral magnetic fields into the interplanetary space can impact planetary systems and human explorations. The multiple observations for the Sun at L4, L5, and L1 positions have a good advantage in studying SEPs in the heliographic view: longitudinal dependence of SEP flux. In addition, the observations can contribute to the monitoring and forecasting of SEP fluxes on a near real-time basis. Here we present the studies of SEPs using multiple remote sensing and in-situ observations during the solar cycle 24. We also show the source regions of SEPs using synchronic Potential Field Source Surface (PFSS) by deep learning model in the heliographic view for the applications of the L4 mission.

12:15 [IV-3-6]

Advantages of L4 Mission in View of Remote Sensing and Deep Learning Applications

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

[1]*Kyung Hee University*

[2]*Korea Astronomy and Space Science Institute*

[3]*KU Leuven (Belgium)*

We have generated solar farside magnetograms from STEREO/EUVI remote sensing observations by our deep learning models. We have used image-to-image translation models based on conditional generative adversarial networks, e.g., Pix2Pix, Pix2PixHD, and Pix2PixCC. We have shown that we can track solar active regions and study their magnetic flux evolution over the solar surface using our artificial intelligence (AI)-generated solar farside magnetograms together with frontside magnetograms. We have applied the AI-generated ones to a part of the boundary conditions for the coronal magnetic field extrapolations, and shown that our results are much more consistent with coronal observations than those of the conventional method. Remote sensing observations outside the Sun-Earth line such as the L4 mission have the following advantages in view of deep learning applications. First, we can generate real-time basis global magnetic field data to cover the full Sun using our AI-generated magnetograms from the STEREO and magnetograms from the L4, L5, and near Earth observatories. The improved global data will be useful as better input conditions for the solar coronal and heliospheric models. Second, to overcome projection effects at the limb of the Sun, we can train a deep learning model to generate from the westside solar data to the central side ones from L1. Then we can apply the model to the westside data from L1 and get extended better quality westside data. We expect that the model can be used not only for the west, but also for the east, north, and south of the Sun. Third, we can generate images, of which instruments are not mounted on the L4 mission, by the model trained with data pairs from the frontside. For this application,

we propose candidate channels in UV and EUV observations. And we suggest several prospects of these applications for solar physics and space weather operation.

제4발표장 Ramada Ballroom IV

IV-4 우주천문

Chair: 전준혁 (충북대)

11:00 [IV-4-1]

Performance Improvement Result of 1 m Telescope in Gwacheon National Science Museum

Elijah J. H. Kim[1,2], Dan Gray[3], Young Jun Park[1,2], Dae Young Park[4], Jae Il Cho[4], Ho Jin[2], Il Hoon Kim[1]

[1]*SLLAB, Inc.*
[2]*Kyung Hee University*
[3]*Sidereal Technology*
[4]*Gwacheon National Science Museum*

In 2021, SLLAB, Inc. completely renovated the one-meter telescope at the Gwacheon National Science Museum
According to the state confirmed before this project, the existing secondary mirror focuser was broken, and a separate focuser was attached between the primary mirror and the focal plane. Nevertheless, the focused image was extremely poor. In addition, tracking for more than 30 seconds was impossible, and pointing performance was also poor.
This project was divided into optical and driving system modification. Optical reverse design was performed, and the positions of the primary, secondary mirrors and focal plane of the existing optical design were found. The problemed secondary focuser was changed and optical alignment was also performed to restore the optical system to its ordinary state.
The tracking and pointing accuracy of the mount has been modified to be superior from the original telescope. The existing incremental encoders at both axes are changed to an absolute type, and the five-phase stepping motors for driving has been replaced to BLDC motors. Through this work, the pointing accuracy satisfies below RMS 10 arcsec, and the tracking accuracy satisfies within 1 arcsec for 10 minute exposure. Finally, it was confirmed that a 10 minute exposured 16 magnitude star was focused as smaller than 2 arcsec.

11:15 [IV-4-2]

A Study on Excavated *Ilseongjeongsiui* Relics

Sang Hyuk Kim[1], Byeong-Hee Mihn[1,2], Yong Sam Lee[3]

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

In June 2021, the remains of *Ilseongjeongsiui* from the Joseon Dynasty were excavated in Insa-dong, Jongno-gu, Seoul. All excavated artifacts were in pieces and fragments. The recovered fragments formed two complete rings and one partial ring. The *Ilseongjeongsiui* is an astronomical instrument created in 1437 during the reign of King Sejong of the Joseon Dynasty. The device was used to measure time by observing the sun during the day and the stars at night. The excavated relics were three rings with detailed scales. The model of *Ilseongjeongsiui* restored in the 1990s had unclear scales and a handle for rotating the rings. It was also possible to examine the rotating structure and the method used to fix the rings. According to the Veritable Records of King Sejong, four *Ilseongjeongsuii* were produced. Except for the two sent to the barracks, the excavated relics are presumed to be one of the two used at Manchunjeon in the palace and Seoungwan, the astronomical office. We designed the reproductions of the excavated rings and will produce an improved restoration model based on this design.

11:30 [IV-4-3]

Literature Analysis of the Angbuilgu of King Sejong's Era

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

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

We analyze the inscription of the Angbuilgu (a Korean scaphe sundial) recorded in the Sejong-Sillok (veritable records of King Sejong) of the Joseon dynasty (1392–1910). According to the literature, the Angbuilgu was first created by Yi Sun-Ji (a Joseon astronomer) and his colleagues in 1434, the 16th year of King Sejong's reign. Although it does not mention hour lines, these would have ideally been marked on the basis of the 100 Gak (hour) system, an hour system dividing a day into 100 intervals, of the Datong calendar enforced at that time. In all extant Angbuilgu, on the other hand, hour lines are marked on the basis of the 96 Gak system of the Shixian calendar introduced in 1654 but the latitude values of Hanyang (capital of the Joseon dynasty) differ according to the period. Besides these changes, we find a variation in the structure. Different from extant Anguilgu, a pinhole-plate was installed at the tip of the gnomon in the early Angbuilgu. A similar structure is also mentioned in the inscription of the Yangyi (a Chinese scaphe sundial) recorded in the Tianwenzhi (astronomy treatise) of the Yuan dynasty (1271–1368). In conclusion, we believe

that this study will be helpful in restoring the Angbuilgu of the early Joseon dynasty.

11:45 [IV-4-4]

Properties of Astronomical Accounts Recorded in the *Hyeonjong-Dongggung-Ilgi*

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

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

We surveyed astronomical accounts from the *Hyeonjong-Donggung-Ilgi*, daily records made by the *Sigangwon* (Royal Educational Office of Crown Prince) at which king Hyeonjong was the crown prince. Of the records of 3,657 days from 1649 to 1659, we collected 3,044 accounts from the records of 2,003 days. This number is approximately five times more than that of the *Joseonwangjo-Sillok* (Annals of the Joseon Dynasty) for the same period. We classified these accounts into 16 categories and then grouped them into five phenomena: atmospheric optics, daylight appearance, apparition, appulse, and eclipse. The accounts of atmospheric optics group occupy about 50% in total. In addition, most of the accounts of this group are omitted in the records of the *Joseonwangjo-Sillok*. In this study, we will present our findings regarding with the properties of the accounts belonging to each group.

12:00 [IV-4-5]

Reports of Stars, Planets, and Other Astronomical Objects Recorded in the Joseonwangjo-Sillok

Junhyeok Jeon

Basic Science Research Institute, Chungbuk National University

Records have been collected and basic analysis has been conducted to perform a study on the information on stars recorded in Korean history books since 2018. The goals of this study can be divided into two main categories; first, to collect records and provide them, and second, to analyze the collected data and identify it from modern stars. Currently, most data on stars, planets, astronomical objects recorded in the Joseonwangjo-Sillok (the annals of the Joseon dynasty) have been collected. The duration of the collection was longer than expected, as there were more records in history books than expected, and there were records using various expressions. However, more detailed data collection became possible. In this study, the records of stars, planets, and other astronomical objects collected in the Joseonwangjo-Sillok are briefly reported.

포스터발표 논문 초록

1부 발표시간 : 10월 27일(목) 14:50~16:20

[P-1] Investigation on Launch Period for Mars Exploration Mission

Sang-Wook Kang, Jae-In Kim, Sung-Soo Jang, Seo-Rim Lee, Yee-Jin Cheon

Korea Aerospace Research Institute

The renaissance of Mars exploration has begun due to the recent success of Mars exploration by emerging space powers such as India, China, and the United Arab Emirates. SpaceX of the United States has a plan to immigrate 1 million people to Mars by 2050 through a Mars settlement program. When exploring Mars, it is very important to send a Mars probe of the maximum mass possible using the least amount of energy. The synodic period between the Earth and Mars is 2.14 years, and the orbits of Mars and the Earth are not exactly circular, and they do not orbit in the same plane. Therefore, the interplanetary transfer trajectory of the Mars probe shows different characteristics depending on the launch time. In this study, we conducted a study on the selection of possible launch period with the goal of launching the Mars probe in 2033 and 2035. Through this study, it was possible to confirm the launch period for Mars exploration mission in 2033 and 2035.

[P-2] Preliminary Ground Test of Thermal Protection System for Atmospheric Re-Entry Vehicle

Dae-Yeong Kim, Gi-Hyuk Choi

Korea Aerospace Research Institute

Atmospheric braking plays a key role in the process of entry, descent and landing (EDL) to atmospheric planets. TPS is the single fault point of the probe, it is the key to the success of the exploration mission. Although there have been specimen-level evaluations up to now, testing of complex specimens such as thermal protection systems has been conducted for the first time. A preliminary test model of the thermal protection system to which the heat-resistant material of the C/C composite base is applied and preliminary ground tests were performed. The test was performed twice to satisfy the maximum temperature of 2200K and the temperature of the aluminum plate material was maintained at less than 150℃. The test results were excellent, and specimens for further testing are being prepared.

[P-3] Development of Mission Planning Rules of Korea Pathfinder Lunar Orbiter Deep-Space Ground System

Dong-Gyu Kim[1], Younju Jo[2]

[1]*Korea Aerospace Research Institute*
[2]*HANCOM inSPACE*

Korea Pathfinder Lunar Orbiter (KPLO) Program Office of KARI has been developing the Korea Pathfinder Lunar Orbiter (KPLO) Mission Operation Center and one of its major function is to generate the bus and payload operation mission timeline and mission command. In order to do generate mission timeline and mission command, there should be the schedule generation rule, conflict detection rule, and conflict resolution rule. The schedule generation rule is defining conditions and restrictions that will combine bus and payload mission requests into a mission timeline and also mapping certain time gaps between adjacent missions. The conflict detection rule is for identifying any mission timeline which violates mission operation conditions and notifying these conflicts to mission planning users. The conflict resolution rule is to resolve detected conflict with predefined conditions without user intervention. These rules are running on the commercial software called the flexplan developed by GMV. The authors has been developing mission planning rules based on the KPLO bus and payload operation concepts and this paper describes the results of mission planning rule development.

[P-4] MOON Based Spectropolarimeter Telescope (MOST)

Ilhoon Kim[1], Sukbum Hong[2], Joohyun Kim[3], Haingja Seo[4], Elijah J. H. Kim[1,5]

[1]*SLLAB, INC.*
[2]*Korean Minjok Leadership Academy*
[3]*Korea Aerospace Research Institute*
[4]*HANCOM inSpace*
[5]*Kyung Hee University*

Because the near-side of the Moon is always facing the earth, it is the best telescope platform for monitoring the earth. And Moon's surface has the advantage of no atmospheric scattering or light pollution and is a stable fuel free observation platform, allowing all longitude and latitude of the Earth to be observed for a month.

Observing the entire globe with a single observation instrument, which has never been attempted before, and calculating the global albedo will significantly help predict the weather and climate change. Spectropolarimetric observation can reveal the physical and chemical properties of the Earth's atmosphere. The zodiacal light is very easy to observe from the lunar observatory, so it will be an opportunity to reveal the origin of the solar system and take a step closer to understanding the exoplanet

system.
Here, we report the advantages of a telescope equipped with a spectropolarimetric camera installed on the surface of the moon and the scientific mission that is expected to be possible.

[P-5] Descent Dataset Generation for the Development of Terrain Relative Navigation Technology

Jae-In Kim

Korea Aerospace Research Institute

Terrain relative navigation (TRN) is essential for safe and accurate landing in planetary exploration. TRN aims to provide accurate position and attitude information of a descending lander using the reference image map for a target area. For this reason, IMU and image datasets, which can be obtained during the descending phase, are required for the development of TRN technology. If the two descent datasets on the real surfaces of a target planet can be obtained, more reliable technology can be developed. This study represents a method of generating descent datasets on Mars. The proposed method first generates IMU dataset at a predefined sampling rate (100 Hz) from sparse trajectory information in the form of timed waypoints. IMU data between waypoints are generated through linear interpolation to secure high temporal resolution. Then, perspectively projected descent images are generated by ray tracing technique from the digital elevation model and ortho-mosaic for a target area. The two reference terrain data are produced from images obtained by the high resolution imaging science experiment (HiRISE) sensor of Mars reconnaissance orbiter (MRO). Experimental results show that the proposed method can accurately reflect both the planned position and attitude of a lander and the elevation of Martian surfaces in generating descent datasets.

[P-6] EDAC Function on PDHU of Danuri

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

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

Danuri has been cruising smoothly toward the Moon since it was launched on August 5, 2022. The PDHU (Payload Data Handling Unit) mounted on Danuri has the ability to receive, store and transmit payload-observed data, and it performs those functions during cruising. However, a single error in the specific area of its own memory caused by an external factor was identified once by telemetries. The EDAC (Error Detection and Correction) function of the PDHU detected and corrected the error automatically, and finally, the ground system confirmed that the error was not included in the payload data transmitted from the PDHU.

[P-7] KPLO X-Band Link Budget Analysis for Received Power Level Prediction in Ground Station during BLT and upto the Moon

Sangman Moon, Changkyoon Kim, Hyeon-Cheol Lee

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO, named Danuri) uses the X-band downlink communication system for downloading the KPLO State of Health (SOH) playback data and payloads data. This KPLO X-band signal is modulated Offset Quadrature Phase Shift Keying (OQPSK) with 8.5 Mbps. To X-pband downlink, the ground station should be locked the carrier signal in exactly center frequency within acquisition range. The acquisition range and process are some different between NASA Deep Space Network (DSN) and Korea Deep Space Antenna (KDSA) because each ground station communication chain is some different. In this paper, for locking the carrier signal, X-band link budget tool used for the predicting the ground station X-band received signal power level during KPLO BLT and upto the Moon. This predicting X-band received signal power level is used for DSN carrier lock Fast Fourier Transform (FFT) input data to the carrier locking.

[P-8] Trajectory Design System Interface and Architecture for KPLO Operation

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

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbiter (KPLO, also known as Danuri) was launched on 4 Aug 2022 (UTC) and is on the way to the Moon through Weak Stability Boundary/Ballistic Lunar Transfer (WSB/BLT) trajectory. Trajectory Design System (TDS), which is a system for KPLO trajectory operation, was introduced to monitor KPLO's trajectory, to design trajectory correction maneuvers (TCM), and to flexibly respond to various contingency situations. This paper summarizes the interface and architecture of the KPLO TDS including operation work flow, key components, and information delivered from/to the Flight Dynamics Subsystem (FDS).

[P-9] Low Energy Plasma and Magnetic Field Variations Observed by Kaguya in the Lunar Wake

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

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

We have studied well-defined narrowband ultra-low frequency (ULF) waves observed in the lunar wake when the Moon was in the solar wind on August 24, 2008, using Kaguya magnetic field and plasma particle data. The observed ULF waves oscillated at a frequency of 24 mHz, which is below the local proton cyclotron frequency (~38 mHz), with a strong wave power and at ~47 mHz with a weak wave power. The separated frequency peaks could be attributed to fundamental and second harmonics of the waves. We found that there was an entry of the solar wind protons into the lunar wake when the ULF wave was observed in the lunar wake. Such entry of the solar wind protons could be an energy source for the wave activity in the lunar wake. During the period of the ULF wave activity, the ion and electron flux oscillations were simultaneously detected in various energy channels. We found the energy dependence of the frequencies of the proton flux oscillations. Such a energy-dependent frequency is thought to be a consequence of the wave-particle resonant interaction. Unlike the protons, the electron flux exhibits spectral enhancements in the same frequency band of ULF waves without energy dependence. In this study, we investigate the wave properties and relationship between the magnetic field and plasma flux oscillations using the magnetic field and plasma data. We also discuss the source mechanisms of ULF waves in the lunar wake.

[P-10] Historical Footprints of Schedule Management for the Korea Pathfinder Lunar Orbiter (KPLO) Program in 2022: Focusing on Event Schedules until the KPLO Launch

Jae-Hoon Song

Korea Aerospace Research Institute

Throughout the start of 2022, final preparations for Korea Pathfinder Lunar Orbiter (KPLO) launch are being completed for Space segment, Ground segment and launch segment, respectively. Flight Model (FM) Assembly, Integration, and Test (AIT) of the KPLO was executed within the given schedule. Design and verification of the KPLO Ballistic Lunar Transfer (BLT) Trajectory was also completed. And Korea Deep Space Ground System (KDGS) including Korea Deep Space Antenna (KDSA) was prepared for ground operations. In this article, historical footprints of schedule management for the KPLO Program are presented focusing on event schedules until the KPLO Launch.

[P-11] The Lunar Region Space Frequency Allocation Review Based on SFCG 32-2R4 Recommendation

Sangil Ahn

Korea Aerospace Research Institute

The design, implementation and operation of various communication links for the its own specific lunar mission have to meet the international frequency allocation recommended by SFCG. SFCG has revised the lunar region space frequency recommendation reflecting new considerations, notions, recognition coming from future new mission needs and requirements of lunar communication and PNT services.

Latest revision of SFCG 32-2R4 includes 7 link usages with 4 link types like lunar surface wireless network, lunar relay to lunar relay cross link, Amateur Radio Operation, Earth to/from Lunar Orbit. In addition, the Earth-based GNSS and in-situ lunar based RSSS/RDSS to lunar surface, search and rescue beacon in lunar vicinity are included in the revision.

All link type and its application information in lunar region in SFCG 32-2R4 shown in this study will be used for guideline for frequency selection in future lunar missions.

[P-12] Image Collection Planning Test of KOMPSAT-6 Image Reception and Processing Element

Taebong Oh

Korea Aerospace Research Institute

KOMPSAT-6 is the second Synthetic Aperture Radar (SAR) satellite in Korea. The ground segment is designed to comply with assigned requirements for KOMPSAT-6 system operation. Image reception and processing element (IRPE) is an element of KOMPSAT-6 ground segment and provides the capability of image collection planning, receiving RF signal from satellite, retrieving observation data and generating standard products. In order to check the function and performance of mission planning for SAR operating modes, image collection planning was tested and the result is briefly presented in the paper.

[P-13] Thermal-Vacuum Test Setup for Optical Test of a Large Optical Payload

Su-Young Chang, Hyung-yun Noh, Youngchun Youk, Eung-Shik Lee

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

In this paper, a test set-up for optical test of large optical payload under vacuum condition is described. Optical payload is very sensitive to environmental vibration perturbation from outside, so it should be isolated as perfectly as possible to reduce any noise during optical test. And whole payload shall be thermally controlled as uniformly as possible to avoid any unintended thermal deformation, which may make worse optical performance. Electrical Components with much heat generation shall be cooed with refrigerated circulator from chamber outside

to keep those within allowable temperature levels during whole test period. Optical payload may be tilted to observe a image on whole fields and channels, And optical target position of collimator may be changed to monitor a image during focus mechanism performance test.

[P-14] Modeling a Laser Tomography Adaptive Optics for the Satellite Laser Ranging System

Howoo Chiang[1], Ji-young Jung[1], Yeonggyu Kim[1], Seok Gi Han[2], Seokyoung Ju[2], Jun Ho Lee[2]

[1]*Hanwha Systems*
[2]*Kongju National University*

We are currently working on constructing the satellite laser ranging (SLR) system. This will be an impeccable instrument to track not only just satellites but other space objects. To improve the optical performance of image resolution, we are developing to apply adaptive optics by using multiple Rayleigh lasers. Using multiple lasers for an adaptive optics analysis is so-called Laser Tomography Adaptive Optics (LTAO). In this poster, we present the simulations of ongoing processes. First, we created a random atmosphere and measured wavefronts from each sensor. Then, we combined wavefronts into telescope pupil wavefronts. Finally, we compared the artificially reconstructed atmosphere with the initial atmosphere and analyzed the residual error. Hopefully, after a few improvements, our LTAO successfully works with the SLR system.

[P-15] Study on the Design of Large Array Digital Radar for the Efficient Space Situational Awareness

Sang Mi Chon, Hyung-Seok Jin

LIG NEX1

Space Awareness Radar should detect small targets orbiting in LEO which most orbiting objects are located in. In order to develop such a radar, beam coverage should be defined first. Because wide search area needs a very large sized antenna, trade off between search area and antenna performances such as power and aperture should be applied. After beam coverage is fixed, antenna shape should be designed. It would be better to separate the transmit and receive antenna to avoid electromagnetic wave leakage from the high power transmit antenna. In order to detect targets moving across search fence fastly, beam resouce manangement would be applied. Digital array radar can manage resouces such as dwell time and search area using transmit beam broadening or frequency muliplexing. In this paper, we will briefly present considerations on the design of the large array digital radar for the space situational awareness and present the designed results.

[P-16] Space Traffic Management for Long-Term Sustainability

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

Korea Aerospace Research Institute

Due to ever increasing number of space objects for mega-constellation, space travel, resource mining, and on-orbit services, Space Situational Awareness (SSA) and Space Traffic Management (STM) is essential to ensure sustainable use of outer space for future generation. Space traffic management can be simply defined as, everybody uses space freely. It encompasses the means and the rules to access, conduct activities in space, and return from outer space, safely, sustainably and securely. It can be realized through, a combination of best practices, guidelines and standards, regulations, technical capabilities, and operational synchronization with data and information sharing. For LTS, we need all-in-one platform for data sharing (ephemeris, flight plans, planed maneuvers, predictions for close approach, and so on). Metaverse allows all of us to engage in a range of different activities into a digital space for actual space. Within STM metaverse, space traffic can be controlled and managed in more safe and realistic way. We can easily access to a metaverse, anytime, anywhere, and most importantly all together. This paper deals with a promising collaborations between domestic and international entities for space traffic management.

[P-17] Concept of Metaverse Platform for Real-Time Space Traffic Management

Youeyun Jung, Jaedong Seong, Saehan Song, Okchul Jung

Korea Aerospace Research Institute

Space activities are diversifying across all areas of the civil, government, and military sectors. Oneweb and SpaceX already launched a mega-constellation satellites into space, and the era of the space internet began. As a result, space has become a global trend, and interest in space traffic management is rapidly increasing to ensure safe space activities between nations or space agencies.

KARI SSA Research Office has selected the following four major functions such as: 1) interoperability and data sharing for real-time space situation data acquisition, 2) fast and accurate data recognition using digital twins, 3) data-based automatic statistics, analysis process, and 4) real-time information sharing with stakeholders. In order to implement all four functions and use them as an integrated platform for all stakeholders around the world, we have studied the concept of the metaverse platform and tried to develop the actual platform.

[P-18] Analysis of Laser Tracking Performance of Spinning Disk of SLR System Using High-Power Laser

Cer-Hee Choi, Suseong Jeong

Hanwha Systems

The Satellite Laser Ranging (SLR) system is the most accurate trajectory tracking system in existence. With the development of multiple-use rockets and satellite manufacturing technology, it is a reality that satellites of various sizes are launched into space at low cost. Accordingly, tracking space objects of various sizes has also become an essential technology. In line with this trend, Hanwha Systems plans to develop the SLR system by the end of 2025.

In order to track Low Earth Orbit (LEO) to Middle Earth Orbit (MEO)-class space objects in accordance with the SLR system using a Common Coude optical system, the specification of a rotating disk of an integrated system that oscillates and tracks a high-power laser is presented. This is because the use of a rotating disk limits the tracking range and impact area.

[P-19] Improving the Empirical Solar Wind Forecast (ESWF)

D. Milošić[1,2,3], M. Temmer[2], S. G. Heinemann[4], T. Podladchikova[5], A. Veronig[2], B. Vršnak[6]

[1]*Korea Astronomy and Space Science Institute*
[2]*Institute of Physics, University of Graz, Austria*
[3]*University of Science and Technology*
[4]*Max-Planck-Institut fuer Sonnensystemforschung,*
[5]*Skolkovo Institute of Science and Technology*
[6]*Hvar Observatory, Faculty of Geodesy, University of Zagreb, Croatia*

The empirical solar wind forecast (ESWF) model is an ESA service that forecasts the solar wind speed at Earth with 4 days lead time. The model uses a simple empirical relation between the area of coronal holes (CHs) as measured in meridional slices in EUV at the Sun and the in-situ measured solar wind speed at 1 AU (Vršnak et al. 2007a). The relation has the drawback that symmetrical speed profiles are produced as the CH rotates in and out of the meridional slice. With adaptations to the ESWF algorithm we aim to improve the precision of the ESWF speed profile by implementing compression and rarefaction effects occurring between solar wind streams of different velocities in the interplanetary space. By considering the propagation times for plasma parcels between the Sun and Earth and their interactions, we achieve the asymmetrical shape of the speed profile that is characteristic of high-speed streams (HSS). Furthermore, we improve upon the automated CH area extraction method and add co-latitude information to the model. We present a statistical analysis for the period 2012–2021 showing that our adaptions improve the ability to predict HSS speed profiles with higher precision, raising the correlation coefficent from cc = 0.35 to cc = 0.40. These results will soon be found in Milošić et al. (under review).

[P-20] Performance Evaluation of the GIM and IRI-2016 in Low Latitudes Using Ground-Based TEC over Vietnam in 2018-2019

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*

In this work, we examine the performance of the Global Ionospheric Maps (GIMs) and International Reference Ionosphere (IRI)-2016 model by comparing them with total electron content (TEC) observations at the magnetic equator. TECs are estimated from GPS data collected at the International University (glat. 10.52°N, glong. 106.48°E, mlat. 1.39°N), Ho Chi Minh City, Vietnam, in 2018–2019. TEC observations show the semiannual anomaly, where TEC is a maximum in the equinoxes and minimum in the solstices. GIMs show similar diurnal and seasonal variation, although TEC observations are lower than GIMs in 2–5 TECU. IRI-2016 model results agree with observed TEC during geomagnetically quiet time. However, during the geomagnetic storm on August 26, 2018, IRI-2016 does not show any significant changes in TEC, while observation shows substantial enhancement of TEC during the main and recovery phase of the storm.

[P-21] A Study for Polarization Properties and Relationship with Geomagnetic Storm of PC1 Waves Detected by BOH Magnetometer during Solar Cycle 24

Jaeyoung Kwak[1,2], Junga Hwang[1,2], Jaeheung Park[1,2], Jiwoo Kim[3], Hangpyo 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]*Geophysical Institute, University of Alaska, Fairbanks, AK, USA*

We statistically analyzed polarization properties and relationship with geomagnetic strom of pc1 pulsations detected by magnetometer located in BOH (Bohyunsan, L=1.3) during solar cycle 24 (August 2009–November 2021). This study is extended work of Kim et al. (2020). Accoding to the previous study, it was revealed that the detected pc1 pulsations frequently occurred during declining phase of a solar cycle, in equinox

season rather than solstice, at midnight and dawn. They also reported that the waves usually are detected during recovery phase of geomagnetic storms. In this study, we concluded that there is a inverse relationship between the intensity of the storms and delayed time to the waves occurrence from the beginning of geomagnetic storms. Also, we founded that the intense storms tend to generate waves that have relatively higher frequency. This result is agreed with a result of Bortnik et al. (2008). Furthermore, we investigated wave polarization properties. Consequently, average of polarization ratio of the waves is about 0.75, and Most of them are slightly polarized with both left-handed or right-handed whose polarization angles are within ± 14°. It is also interesting that linearly polarized waves rarely occurred.

[P-22] Comparison between Observations and Hybrid Simulations: Cold Protons and Helium Ions Energized by EMIC Waves in the Inner Magnetosphere

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

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

Recent observations provide that electromagnetic ion cyclotron (EMIC) waves generated by hot anisotropic ($T_\perp > T_\parallel$) protons (~10-100 keV) play an important role in energization of cold (< 1 eV) protons (H^+) and helium (He^+) ions in the inner magnetosphere (L < 6). Using a hybrid simulation code, we examine how EMIC waves interact with cold H^+ and He^+ ions. The simulation results show that the cold ions are energized in two steps. In the first step, EMIC waves are excited in the H-band, higher frequency branch ($\omega/\Omega_H \sim 0.4$), and interact with cold H^+ and He^+ ions. The cold ions are mostly energized in the direction perpendicular to the background magnetic field. The energization in this step is not associated with high-energy tail formation but bulk heating, a picture consistent with recent observations in the inner magnetosphere. In the second step, the dominant frequencies of H-band EMIC waves shift toward lower frequencies and lower wave numbers as the hot proton temperature anisotropy decreases. The dominant waves occur in the He-band ($\omega/\Omega_H \sim 0.2$). During this stage, energization occurs during nonlinear evolution of EMIC waves, which is seen after about 150 ion gyroperiods corresponding to ~40 seconds. This non-linear evolution is caused by a mixing plasma between particles in the adjusted grids. The energization of cold H^+ and He^+ ions occurs not only in the perpendicular direction but also in the parallel direction, Cold He^+ ions are much more energized than cold H^+ ions because the He^+ ions is resonant with He-wave in this stage. By comparing recent observations and the present simulation results, we suggest that low-energy particle energization by EMIC waves occurs at early stage of wave generation without nonlinear evolution of EMIC waves in the inner magnetosphere.

[P-23] Multipole Approximation of Solar Surface Magnetic Field and Its Possible Application to the Solar Interior Currents

Bogyeong Kim, Yu Yi

Chungnam National University

Since Dynamo mechanism has many problems such as imbalance between observation and theory and setting excessively approximate coefficients, in this study, we expanded a solar magnetic field in the form of a multipole component from the perspective of spherical harmonics, and using this, we present the dynamo model constraints. The Wilcox Solar Observatory (WSO) supplies the solar corona magnetic field coefficients of the spherical harmonics of each Carrington Rotation calculated based on the solar surface photospheric magnetic field remotely sensed. To estimate the internal current system producing the global solar coronal magnetic field structure of the Sun and its developments we calculate the multipole components of the solar magnetic field using the WSO data from 1976 to 2019. The prominent cycle components over the last 4 solar activity cycles are axis-symmetric fields of the dipole and octupole. This implies that the current inversion driving the solar magnetic field reversal originates from the equatorial region and spreads to the whole globe. Thus, the more accurate solar dynamo model must include the explanation of the cause and evolution of such solar internal current dynamics.

[P-24] Measurement of Cosmic Rays and Internal Background Radiations of CLYC and $LaCl_3$

Sunghwan Kim[1], Phan Quoc Vuong[2], Hongju Kim[2], Ukwon Nam[3], Won-Kee Park[3], Young-Jun Choi[3], Sukwon Youn[4], Sung-Joon Ye[4]

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

For the measurement of cosmic rays on the lunar surface, CLYC and $LaCl_3$ scintillators were investigated as radiation sensors. The scintillation decay time of the two scintillators depends on the type of radiations, such as gamma-ray and neutron. Therefore, it is possible to separate and evaluate gamma rays and neutron rays from the measured energy spectrum by the PSD method. In this study, cosmic rays and internal background radiation were measured at Manhangjae (1,350 m above sea level) in Kangwon-do to evaluate the characteristics of these scintillators against cosmic rays. Both scintillators were measured with good separation between neutrons and gamma rays. In addition, both

scintillators observed the U and Th series of internal background radiation, but $LaCl_3$ confirmed that neutron and internal background radiation could be measured separately. We confirm that these scintillators effectively measure neutron and gamma-ray separation on the lunar 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)

[P-25] Quasi-Periodic Variation of Microwave Brightness Variation along a Solar Flare Loop

Sujin Kim[1], Jeongwoo Lee[2]

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

We have studied the solar flare, SOL2013-10-28T02:01 (GOES class M9.1), which is characterized by quasi-periodic variations of microwave and hard X-ray bursts. The microwave maps are obtained with the Nobeyama Radioheliograph (NoRH) at 17 GHz and 34 GHz and hard X-ray maps, 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 with each separated by about 20 sec time interval, and a dominant microwave source appears to be dynamically changing its position within a simple loop oriented north-south near the limb. 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. 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 source at the times between the peaks appears in the south. Based on the time scale and intensity variation, we argue that this phenomenon can be attributed to neither an MHD oscillation nor actual change in the location of the high-energy electrons, and that the northern source is due to the precipitating high-energy electrons and the southern source is due to the trapped electrons.

[P-26] Response of European Ionosphere during the First G3 Intense Geomagnetic Storm in 25 Solar Cycle

Jeongheon Kim[1], Young-Sil Kwak[1,2], ChangSub Lee[3], Jae-Wook Lee[1,2], Hosik Kam[1], TaeYong Yang[1], GeonHwa Jee[3], YongHa Kim[4]

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

On November 1 and 2, 2021, two Halo CMEs in the Sun ejected an enormous number of high-energy particles into interplanetary space. Its events were directed toward Earth and reached Earth on November 4, generating a G3 level (= Kp 7) extreme geomagnetic storm. We catch the responses of the ionosphere and thermosphere that occurred in Europe during the G3 strong geomagnetic storm on November 4, 2021, using various observational data. This event was the first G3 geomagnetic storm since the beginning of the 25-solar cycle and significantly impacted the global ionosphere. In particular, we observed the positive storms in the middle and low latitudes of Europe caused by meridional neutral winds propagation. In contrast, we detected negative storms in the high latitudes due to the increase in thermospheric density (upwelling). These responses were demonstrated by latitude-distributed chains of ionosonde and TEC observations. Above all, we obtained evidence of actual thermospheric equatorward and westward winds through high- and mid-latitude thermosphere wind data (Svalbard FPI & ICON/MIGHTI). In this study, we confirmed the theory of the effect of the thermospheric components during the geomagnetic storm.

[P-27] A Potential Mechanism for Banded Chorus Generation

Kyungguk Min

Department of Astronomy and Space Science, Chungnam National University

Magnetospheric chorus often arises in two spectral bands in frequency with a gap in intensity at half the electron cyclotron frequency, fce/2, in which case it is called the banded chorus. Despite routine satellite observations of banded chorus, its generation mechanism is still debated. It has been suggested that the two bands are generated by two different anisotropic electron populations with different temperatures. In between these two populations is a rather isotropic population, called the plateau or beam, that is believed to suppress nonlinear growth of chorus at the spectral gap. Previously, we have demonstrated through particle-in-cell simulations in a dipole-like magnetic field that an isotropic plateau population in the intermediate energy range can suppress rising chorus elements at fce/2. In this paper, we show that the resonant current contributed by the phase-trapped plateau electrons (forming a phase space hill) can act in a way to cancel the resonant current by the well known phase space hole that drives nonlinear chorus growth. This process occurs in addition to linear cyclotron damping suggested in earlier studies and the resulting nonlinear damping can exceed the latter effect.

[P-28] 3D Global MHD Simulation of Uranus's Magnetosphere

Kyung Sun Park

Chungbuk National University, Korea

Global magnetohydrodynamic (MHD) simulation has been quite successful in reproducing overall magnetospheric dynamics and ionosphere phenomena for the Earth. However, understanding how the energy and momentum transfer from the Sun to the Uranus is a complex problem with many different aspects. Also, there are few simulations with spatial resolution high enough quantitatively study the effects of solar wind and tilt exist. We performed a global MHD simulation of Uranus magnetosphere to answer the question, how magnetic reconnection drives the magnetosphere and how the overall structure of the magnetosphere changes under variables tilt. We consider the effects of the title angle of two cases (e.g.,−23.63° and +39.17° for southward IMF and northward IMF) on the efficiency of the coupling between the solar wind and the magnetosphere. The simulation number of grid points is (nx, ny, nz) = (600, 400, 400) with a uniform grid spacing 0.5 Ru. We set a uniform solar wind with a density n_{sw} = 0.05 cm^{-3}, a velocity, V_{sw} = 400 km/s with pure southward IMF Bz = 0.3 nT as input parameter by New Horizons observation.

[P-29] ITU-R Studies on WRC-23 Agenda Items 1.12 and 9.1, Topic a) Associated with Sun and Space Weather Observation

Su-Chan Bong[1], Kichang Yoon[2], Jiwoong Park[2], Hwangjae Rhee[3], Jongmin Park[4]

[1]*Korea Astronomy and Space Science Institute*
[2]*National Radio Research Agency, MSICT*
[3]*SyncTechno*
[4]*Electronics and Telecommunications Research Institute*

The International Telecommunication Union (ITU) is the United Nations specialized agency for information and communication technologies, and the ITU Radiocommunication Sector (ITU-R) plays a vital role to ensure interference free operations of radiocommunication systems through implementation of the Radio Regulations, which is updated through the World Radiocommunication Conferences (WRC). In the upcoming ITU World Radiocommunication Conference 2023 (WRC-23), the Agenda Item 1.12 on a possible new secondary allocation to the Earth exploration-satellite (active) service for spaceborne radar sounders in the 40−50 MHz, and the Agenda Item 9.1 topic a) on the technical and operational characteristics, spectrum requirements and appropriate radio service designations for space weather sensors will be discussed. These agenda are associated with the operation of current Korean facilities for Sun and space weather observation. We report the results of related studies conducted by ITU-R Working Party 7C (WP 7C). These results will be reviewed and discussed further to prepare a consolidated report in the upcoming second session of the Conference Preparatory Meeting for the WRC-23 (CPM23-2), and that report will be used in support of the work of WRC-23.

[P-30] A Newly Developed MPI-Based Solver for Non-Isotropic Gravitational Field in the Solar Interior

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

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

The solar interior cannot be observed using electromagnetic waves. Even though helioseismology provides a strong tool to investigate the solar interior using acoustic-gravity waves, our understanding of the dynamics operating in the solar interior is fairly limited. Traditionally, numerical simulations of the solar interior have been focused on an isolated convection zone, so a self-consistent mechanism controlling magnetic fields and flows in an entire solar interior is still unclear. Since the existence of the solar magnetic field and the solar rotation inevitably puts the solar interior in a non-isotropic state, we have developed an MPI-based solver so as to derive the gravitational field from a non-isotropic density distribution by solving a self-gravity equation. We show how fast the calculation speed of this solver is and also demonstrate that its calculation result well matches an analytical solution. By incorporating the solver into our existing MPI-based MHD code, we can investigate the self-consistent mechanism governing the solar internal dynamics.

[P-31] Irregularities of Nighttime Mid-Latitude Topside Ionosphere in Swarm Satellite Data

Hosub Song[1,2], Jaeheung Park[1,3], Jaejin Lee[1], Yu Yi[2]

[1]*Space Science Division, Korea Astronomy and Space Science Institute*
[2]*Department of Astronomy, Space Science and Geology, ChungNam National University (CNU)*
[3]*Department of Astronomy and Space Science, University of Science and Technology (UST)*

We analyze irregularities in the topside ionosphere at nighttime mid-latitude using the latitudinal difference of plasma density (Ne) structures from Swarm-A and C satellites. We investigate the features of the irregularities by calculating the latitude difference with which two satellites with different longitudes observed the same irregularities. We look at statistics by collecting events that satisfy a minimum correlation of the two data and a minimum magnitude of the plasma density fluctuation. Then, the geographical distribution of events and the tendency

of propagation directions have similarities with the nighttime Medium-Scale Traveling Ionospheric Disturbances (MSTIDs). Additionally, in the ionosphere higher than the Swarm satellite altitude, the fluctuations is analyzed using the topside Total Electron Content (TEC). Moreover, we confirm that the dependence of the propagation direction on MLT is weak.

[P-32] Origins of Seasonal Variations in Cosmic Ray Intensity Observed by Neutron Monitors

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

[1]*Chonnam National University*
[2]*Chungnam National University*

Count rates of neutrons observed by neutron monitors show the modulations of intensity, such as periodic variations or transient events. The seasonal variation and its origins were difficult to determine by using data of the single neutron monitor (Jeong & Oh 2020). In this study, we use the daily data of 16 neutron monitors from 1964 to 2020 to configure out the seasonal variations and its origin. In order to determine the pure seasonal variations, the solar cyclic variations in cosmic ray intensity were eliminated by normalizing to the yearly mean or median and selecting the representative value of each day from the mean or median for 57 years. The results of Cox and Stuart trend test show that the cosmic ray intensity showed a clear seasonal trend for four ways of data transformation. We discuss the origins of seasonal variations and the several statistic methods to exclude the outliers resulting from sporadic effects and to classify the seasonal variations.

[P-33] Verification of the Radiation Exposure Estimation Models with Aircraft-Based Dose Measurements

Dong-Hee Lee, Jiyoung Kim

National Meteorological Satellite Center, Korea Meteorological Administration

Radiation exposure of aircrew and passengers should be accurately monitored and properly notified to protect their health from the adverse effect of ionizing radiation. In general, the radiation originated from galactic cosmic rays (GCR) or/and solar energetic particles (SEP) are estimated by numerical estimation models because every commercial aircraft could not embed an instrument for measuring the radiation dose rate. In this study, we calculated the three models, NAIRAS (NASA), CARI-7 (FAA), and KREAM (KMA), and then estimated the radiation of aircraft crew and passengers. We statistically analyzed the error characteristics of models by the ARMAS (NASA) data that measures the ambient radiation environment at commercial aircraft altitudes. We used the effective dose values of 579 flights from November 2013 to March 2022. This study period corresponds to parts of solar cycle 24 and 25. All models tend to underestimate the total cumulative dose during flight. The higher the total dose rate, the bigger the model errors are estimated. The coefficient of determination (R^2) between the assessment models and ARMAS measurement are CARI-7 (0.92), NAIRAS (0.91), and KREAM (0.88), respectively. The root mean square error in μSv of NAIRAS, KREAM, and CARI-7 are 5.58, 5.44, and 3.77, respectively. The bias in μSv of NAIRAS, KREAM, and CARI-7 are −7.44, −8.04, and −11.18, respectively. The result of this study implies that the underestimated radiation gives aircrew and passengers a reduced risk perception for ionizing radiation. The model errors should be checked and improved in cases with high dose rates.

[P-34] Characteristics of Solar Wind Chemical Composition for SEP Event Associated with GLEs

Jongil Jung[1], Suyeon Oh[2], Yu Yi[1]

[1]*Chungnam National University*
[2]*Chonnam National University*

The ground level enhancement (GLE) is a sudden increase of the neutron monitor (NM) count rate related to some solar energetic particles (SEPs) events. The GLEs are rare and have been recorded 73 times until now since it was first identified in 1942. Oh et al. (2010) found the differences in GOES differential proton fluxes between SEPs associated with and without GLEs. The SEPs associated with GLE showed a large increase and clear peak in proton flux of all energy channels. This time we examine the chemical composition of SEPs associated with GLEs. We use the data of the Solar Isotope Spectrometer (SIS) onboard the Advanced Composition Explorer (ACE) satellite at the time of SEP events identified with GOES proton flux data. Our goal is to find which chemical elements in the solar wind have a greater association with the GLE. We found different features in some elements, sulfur, silicon, and iron. Based on this study, we will perform statistical analysis on many SEP events including GLEs.

[P-35] Statistical Analysis of Geomagnetic Storms in Solar Cycle 24

Sejin Cho[1,2], Jung-Min Shin[2], Ji-Moon Cho[3], Dong-hee Kim[3], Ho-Jung Park[2], Dae-Yong Lee[2], Yong-Sik Shin[2,3], Seung-Gyu Hwang[2,4]

[1]*Chungnam National University, Korea*
[2]*Space Weather Team, Republic of Korea Air Force*
[3]*Department of Physics, Yonsei University*
[4]*Department of Physics, POSTECH*

By using solar wind data from OMNI, space environment forecast data from ROKAF, geomagnetic disturbance indicies from WDC, CHIMERA data from Solar Monitor and CME

information from CACTUS, we performed a full survey to closely analyze the geomagnetic storms of the solar cycle 24. As result, a total of 290 geomagnetic storm(Kp >= 5) events occurred during the 2010–2022 period, categorized into three geomagnetic storms: CIR, CME, ETC (+HCS). Among those events, the ratio of each of the CIR, CME, and ETC events is 51.38% (149 count), 35.17% (102), and 13.45% (39), respectively. The average dst of 149 CIR is −44.8, the average dst of cme is −77, and the average dst of geomagnetic disturance of unknown or complex factor is −47.9. The frequency of occurrence of geomagnetic disturbance is highest in CIR, but the intensity is stronger in CME.

[P-36] Auroral Occurrences with Different Geomagnetic Activities at Jang Bogo Station, Antarctica

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

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

The visible auroras has been observed by Aurora All-sky camera (ASC) at Jang Bogo Station (JBS), Antarctica since 2018. The occurrence of the aurora at JBS shows systematic variations with magnetic local time (MLT) and it seems to be associated with the location of JBS with respect to auroral oval. This indicates that the JBS is located in the auroral oval or in the polar cap, depending on the MLT. In other words, the JBS may be located near the boundary of the polar cap and the auroral oval. Since the poleward boundary of the auroral oval is known to vary with magnetic activity level, it can be expected that the spatial location of the auroral occurrence at JBS should also show the variations with magnetic activity. As the magnetic activity increases, the auroral oval expands toward equatorward. In this paper, we investigate the auroral occurrences at the different magnetic activity conditions in order to see the variations of the poleward boundary of the auroral oval with magnetic activity.

[P-37] 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 equator between the proton cyclotron frequency and the lower hybrid resonance frequency. They are usually observed on both sides of the plasmapause, where they can effectively scatter energetic electrons and protons. Their characteristics in plasmaspheric plumes, however, 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 shifts the peak of wave normal angle toward a lower angle. In addition, approximately 80% of selected magnetosonic wave events are observed simultaneously with the plasmaspheric hiss, which is known to be most effective in scattering electrons in the plume.

[P-38] Investigation of Mesospheric Gravity Wave Sources Over Mt. Bohyeon Observatory (36.2°N, 128.9°E) by Backward Ray-Tracing

Jun-Yeong Hwang[1], Young-Sook Lee[1], Yong Ha Kim[1], In-Sun Song[2], Hosik Kam[3], Young-Sil Kwak[3,4], Tae-Yong Yang[3]

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

Gravity waves can be generated by various sources, such as orography, convection, fronts and jet in lower atmosphere. We investigate sources of gravity waves observed with all-sky camera at Mt. Bohyeon Observatory (36.2°N, 128.9°E) for the period of 2017–2019. A total of 150 gravity wave events were identified from the O I 557.7 nm airglow images, which may reflect wave activities at the altitude of 95 km. We trace back the propagation of individual wave event by using backward ray-tracing method with the wave parameters that were derived from our previous study. We will present the results of ray-tracing and will discuss the sources of observed mesospheric gravity waves over the Korean peninsula.

[P-39] Analysis of Residual PRNU of GOCI-II Base on On-Ground/In-Orbit Calibration Data

Gmsil Kang, Songyong Cha, Sang-Soon Yong, Jo-Young Min

Korea Aerospace and Research Institute

The Geostationary Ocean Color Imager (GOCI)-II developed for ocean color monitoring around the Korean Peninsula from a geostationary platform has been performing observation mission since 2020. In this paper, residual PRNU of GOCI-II is analyzed based on its on-ground calibration results and in-

orbit solar calibration. Relative radiometric gains of GOCI-II has been measured with different light source. At first, its radiometric gain for each spectral band was measured by using a large integrating sphere during on-ground calibration. Because integrating sphere is considered as a uniform source, pixel-to-pixel non-uniformity can be characterized. After the launch, the radiometric gain has been measured periodically using the on-board calibration device.
Radiometric gain parameters of the GOCI-II shows variation over matrix (PRNU, Pixel Response Non-Uniformity) due to characteristics of CMOS detector and video electronics. Residual PRNU of the GOCI-II is analyzed by using the on-ground gain and in-orbit radiometric gain. It is noticed that residual PRNU is caused by random noise of raw image and gain matrix. Also, residual PRNU is induced by the different light source used for radiometric calibration. This residual PRNU shows variation over spectral bands and it is considered due to spectral response variation over pixel-by-pixel.

[P-40] Container Development for the KPLO Launch Site Transportation

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

Korea Aerospace Research Institute

The Korea Pathfinder Lunar Orbitor (KPLO) had been launched by Space X in cape canaveral space force station. To launch the KPLO, it is necessary to transport the KPLO from KARI to cape canaveral space force station by freighter. Therefore container for the KPLO transportation is developed.
The container need to be developed so that temperature, humidity, shock, etc are kept constant during transportation of the KPLO. And the container should be developed considering the size that can be loaded in freighter (B747). This poster describes size, structure, test result of the container for the KPLO transportation.

[P-41] KPLO Flight Software State of Health (SOH) Test at the Launch Site

Soo-Yeon Kang

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) was successfully launched on August 5, 2022 at the Cape Canaveral Space Force Station by Space-X Palcon-9 launch vehicle and is currently cruising toward the moon. KPLO, which was transported to the launch site, was subjected to final condition check test at the launch site after completing all the tests at the KARI site in Korea. The purpose of this test conducted at the launch site is to check whether the satellite is in a launchable state, and to detect any faults that may occur during transportation to the launch site. In this paper, we present the contents and results of the Flight Software State of Health test performed at the launch site.

[P-42] Tendency Analysis of Control Error for Hand Over Time

Woo Yong Kang

Korea Aerospace Research Institute

For GEO-KOMPSAT3 (GK3), the goal is to automatically recover the failure without safe hold mode even if a simple failure occurs in the hardware. In particular, in the event of a temporary failure of the satellite computer, the design is being carried out to enable normal operation using another computer. This process is defined as hand over. Attitude control can not be performed during hand over. Therefore, the attitude control increase during hand over. In this paper, we analyze the tendency of control error for hand over time.

[P-43] Characteristics and Direction of Satellite Insurance

Kyung-Jin Kwon

Korea Aerospace Research Institute

Medium and large-sized satellite development projects have a high degree of difficulty and uncertainty, and the budget scale is relatively large. Therefore, neither domestic non-life insurance companies nor re-insurance companies are able to acquire satellite insurance, and there are not many non-life insurance companies around the world that handle satellite insurance. Such limited market conditions create a structure in which the insurers who buy insurance have no choice but to dominate the market. In addition, as the demand for satellites in Korea continues to increase, the demand for domestic satellite insurance will inevitably increase. Therefore, in this paper, I would like to introduce the characteristics of satellite insurance and discuss the direction of progress.

[P-44] Attitude Control Data Analysis of the KPLO's Correction Maneuver for the Launch Vehicle Trajectory Dispersions

Jaewook Kwon, Kwangyul Baek, Dawoon Jung, Hanwoong Ahn

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) has several missions supposed to take images and measure scientific data at the Moon. In order to get the Moon from the Earth, it needs to adjust the way to follow the trajecotry that has been designed. Attitude Orbit Control Subsystem (AOCS) has developed several control modes and verified each performance to check

compliance. The first delta velocity maneuver is necessary to adjust KPLO's velocity to make it up to the planned trjectory of the launch vehicle which has to be supplied.
This paper cites that the trajectory correction maneuver which is the one of early operations for the KPLO has been conducted under the planned scenario and the results of the its flight data has been analized to check out whether the task has been done within the required values in AOCS.

[P-45] Validation Data Verification Method for Power EGSE

Kyung-Keun Kim[1], Seung-Hwan Park[2]

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

Electrical Ground Supporting Equipment (EGSE) of Satellite power system should be moved many time during Assembly integration and Test (AIT). When EGSE is moved to other site for Satellite test, EGSE Test Engineer should verify that it is normal or abnormal condition before link to satellite. In this paper, We will check validation data from power EGSE can show condition of EGSE, based on validation data at middle-size satellite.

[P-46] Interference Analysis for GPS and S-Band Receiver in Satellite System

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

Korea Aerospace Research Institute

The satellite is equipped with receivers to receive the GPS and S-band signal. For normal operation, there should be no external interference signal near the operating frequency range. So, it is necessary to limit the strength of these signals. Therefore, the EMC standard of satellite defines and controls the radiated emission mask. However, during the equipment development process, the allowed radiated emission mask is exceeded and a waiver request occurs. In this case, it should be evaluated whether the power input to the receiver is below the permissible level in consideration of the system geometry. In this paper, the case of analyzing the effect on the receiver when the radiated emission mask is exceeded will be dealt with.

[P-47] Horizontal Positioning Method for Deep Space Exploration

Kiduck Kim

Korea Aerospace Research Institute

One of characteristics of the navigation system for deep space probes is the environment in which GPS cannot be used. To overcome this feature, ground-based systems likewise the Deep Space Network (DSN) is used to know where they are in space. However, communicate with these systems may not be possible in some cases as well as delay in communication between the probes and the ground system. Therefore, additional use of other sensors is required for the autonomy of the navigation system.
In this paper, we introduce two methods of fixing the horizontal position to construct autonomous navigation system. The first is a celestial-based positioning by measuring the altitude of visible stars. It is a very traditional way to know one's location, which navigators have used a lot. The second method is terrain-based positioning using a normal vector of support plane. The observed normal vector can be expressed in relation to inertial frame and includes information on a horizontal position. In this paper, we present the two methodologies and compare them by simulation results.

[P-48] Research on Imaging Methods to Acquire Wide-Area Images

Dong-Oh Kim, Jun-Yeong Bok

Satellite Ground Station R&D Division,
National Satellite Operation and Application Center,
Korea Aerospace Research Institute

The Korea Aerospace Research Institute (KARI) operates various Low Earth Orbit (LEO) satellites.
Some satellites performs a imaging mission and a down-link mission according to the ground command.
Some satellite offer strip imaging method. Strip imaging method means performing the imaging mission in the same direction as the moving direction of the satellite.
Wide-area imaging means acquiring images of a continuous wide area by performing multiple strip imaging methods.
In this paper, a method for acquiring wide-area images using the strip imaging method of LEO satellite is summarized.

[P-49] Research on the Design of High-Reliability Electronics Operating in Space Environments

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

SpaceK Inc

In the New Space Generation, there is a growing interest in space technology in the civilian sector, but design technology is required for the stable mission execution of electronic unit exposed to space environments.
In this paper, we have proposed and precessed, and we have proposed procedures of researching and developing more robust

electronic unit using the ANSYS Electronic Enterprize (HFSS/SI wave/Icepack/Mechanical) to verify the design technology by considering procedures for designing electrical unit technologies suitable for space class, and designing included boards used in satellites.
In particular, the design was carried out taking into analysis the methods of securing the reliability of the satellites, such as Reliability, Worst Case Analysis and Part Stress Analysis.

[P-50] Introduction to the Process of Verifying the Electrical Interface of Launch Vehicle Facility between Satellite and Electrical Ground Support Equipment

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

Korea Aerospace Research Institute

It is necessary to check the status of satellite if it is ready to launch before the satellite is launched. The status of satellite is known through the electrical interface of launch vehicle (LV). The launch facility user should ensure that the electrical interface of LV is reliable.
The electrical interface of LV verification is usually done in three phase. The user verifies the connections between the end of stage2 of LV and the electrical ground support equipment (EGSE), between the beginning of stage 2 and the EGSE, and between the payload adapter of the satellite and the EGSE. When checking the electrical interface of LV, compact sized validation unit can be used instead of satellite, since the satellite can not be moved every time.
In this paper, we introduces the procedure for verifying the electrical interface of LV between satellite and EGSE before the satellite is launched on the launch site.

[P-51] Analysis of the Effects of Flexible Model on the Controller Based on Thrusters for Low Earth Orbit Satellite

Yong-Bok Kim, Hong-Taek Choi

Korea Aerospace Research Institute

After separating from launch vehicle, the satellite should be maneuvered to point the solar array normal vector to the sun and maintain sun pointing and it should be also maneuvered to align the positive yaw axis with the desired del-V burn direction using thrusters as an actuator. The spacecraft dynamic model is composed of a lot of modes and each mode has a natural frequency calculated from physical characteristics and spacecraft configuration. The adjusted number of modes would be selected to reduce the calculation time. This paper shows the effects of flexible model in consideration of flexible structures such as solar arrays on the thruster based controller through the controller design process.

[P-52] Conceptual Design of Mechanical Interface for On-Orbit Servicing of Standard Space Probes

Eui Keun Kim

Korea Aerospace Research Institute

In the new space era, the necessity of conducting advanced research and challenging tasks for the development of future space technology is gradually emerging. Space exploration and on-orbit servicing is one of the most challenging tasks in the New Space era. Service areas of on-orbit servicing include close-up observation, refueling, repair, orbit change, and replacement of parts. If on-orbit servicing is applied to a standard space probe, it can be used by granting deep space exploration and additional missions as well as extending the lifespan. In this study, the design direction of the Quick Connector concept for refueling connection was described to extend the lifespan by supplying fuel to the standard space probe. In addition, the conceptual design direction of the modular electrical device connector for easier replacement and repair of the electrical unit's fault repair H/W upgrade is also described.

[P-53] GEO-KOMPSAT-2A AMI Image Navigation and Registration Performance and Anomaly Detection for Quality of AMI Images

Junho Kim

National Meteorological Satellite Center (NMSC), Korea Meteorological Administration (KMA)

GEO-KOMPSAT-2A (GK2A) was launched on December 5, 2018. KMA started official data release of AMI since July 25, 2019 after In Orbit Test (IOT). The observation image received from the ground station is distorted due to perturbation of the celestial body and inaccuracy of the Line of Sight (LOS). Image Navigation and Registration (INR) is the process of correcting this image distortion. Image navigation is the process of matching the location of an image pixel with latitude and longitude on Earth. Image registration is the process of maintaining the location of matching pixels within an image or between images. Therefore, INR is a measure of the absolute pointing accuracy and stability of the image. INR performance is an important quality indicator for GK2A AMI data utilization.
In this paper, we introduce the results of monitoring INR performance statistics for AMI Full Disk (FD) images, such as image navigation residuals, Channel to Channel Registration (CCR), With in Frame Registration (WFR) and Frame to Frame Registration (FFR). Also, we introduce the automatic monitoring method to detect the cases of image anomalies in GK2A AMI images, such as instant striping of image and partial loss of image.

[P-54] A Time-Efficient Method for End-to-End Test between Ground System and Satellite System

Jin-Hyuck Kim, Jin-Ho Lee

Korea Aerospace Research Institute

An end-to-end (ETE) test is one of the items to be performed in the final stage of the satellite's assembly and test, which verifies the integrity of communication between ground system and satellite system. Recently, an ETE test shall be carried out with a greater variety of test items within a limited time according to increasing cases of developing ground system and satellite system by different institutions or companies.
In this paper, we introduce a time-efficient method for an ETE test.

[P-55] A Study on Deep Neural Network-Based Techniques for 6DOF Posture Estimation for Known Non-Cooperative Space Objects

Jin-Hyung Kim[1], Hyunho Jeon[2]

[1]*Korea Aerospace Research Institute*
[2]*Agency for Defense Development*

Thanks to the development of space launch vehicle technology and semiconductor technology, conditions are being created to perform various missions that have not been attempted before in space. The decline in launch costs into space has increased the possibility of extending the mission life of existing one-off satellites or active/passive removal of space debris. Recently, related commercial activities are also increasing. Furthermore, the maturity of deep neural network-based AI technologies in ground applications such as autonomous driving is increasing, and these flows naturally lead to space applications, as shown by the SPEED/SPEED+ dataset and related technologies disclosed by ESA. In this study, we researched a deep neural network technique for relative 6 degrees of freedom posture estimation of non-cooperative space objects among element techniques for performing on orbit service in space. Conventional studies tried to estimate the direction and location information of the input image with a single end-to-end neural network, so the estimation accuracy was remarkably low. To achieve higher postural estimation accuracy, we consider a step-wise approach. The method proposed in this study goes through a neural network that first detects key-points of the target object without performing 6 degrees of freedom posture estimation directly from the input image. The primarily detected key-point vector finally estimates the relative posture of 6 degrees of freedom through a neural network that estimates only the posture.

[P-56] Investigation and Review of International Radiation Test Facilities to Expand the Infrastructure for the Development of Space-Grade Electronic Components

Tae Hyo Kim, Woojun Lee, Geun-Young Park

Korea Aerospace Research Institute

Satellites use high-reliability electronic components with radiation-resistant properties, and most of these components are imported from countries with advanced space technology, such as the United States and European countries.
Despite the success of the Nuri launch vehicle, there are restrictions on the selection of the launch vehicle and the use of electronic components for the payload due to the IATA agreement.
Korea has excellent semiconductor design and manufacturing technology, so it has an advantage in localizing parts, but the experimental facilities for the verification of radiation tolerance are very insufficient.
In this paper, we would like to discuss the current status of international radiation testing facilities for the localization of electronic components for space and future expansion plans.

[P-57] Case Study for Thermal Control Design of Deep Space Explorers

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

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

Deep space explorers mean the spacecraft that explore other planets, moon, asteroid, comet, etc. over the Earth orbit. Satellite in the Earth orbit is under relatively mild-varying stable thermal environments, which could be thermally designed to be controlled maintaining its temperatures within the temperature requirements. The thermal control technologies for the satellites are well developed, and sufficiently mature. Because this current technology status, there is not difficulties in designing the thermal control for the satellites. On the other hand, the deep space explorers experience different thermal environments compared with around the Earth orbit; they are determined according to each designed missions, that is, interplanetary flight, orbiting in or landing on other planets and the Moon, exploring the asteroid and comet; they are more serious hot and cold conditions than those of the Earth orbit. The thermal control for the deep space explorers could be begun based on the thermal control methods of the satellites; however, it is nearly impossible to maintain thermal safety within required temperatures during thermally serious mission phases. It is therefore essentially required to apply advanced thermal control technologies. In this study, it is investigated that the case study for the thermal design of abroad deep space explorers which are developed applying the advanced thermal

technologies. The major technologies are such like a radioisotope heater unit (RHU), using the waste heat of a radioisotope thermal generator (RTG), a two-phase thermal switch, a variable heat pipe, high temperature multi-layer insulation (MLI), a gravity-assisted two-phase fluid loop, a pumped fluid loop. It could be finally understood which technologies are considered for the thermal design of the deep space explorers as each mission orbit condition.

[P-58] Introduction of Compact Advanced Satellite500-4 (CAS500-4) Critical Design Applied with CAS500 Standard Platform

Jaehwee Doh, Junseong Kim, Jin-Gon Bae, Seok-Soo Kim

Korea Aerospace Industries, Ltd.

As according to national space development road map, The CAS500 with 500 kg mass was developed for standard platform and export strategy model. The CAS500-4 is the first satellite of utilizing a standard platform that has been developed to minimize design change with respect to the CAS500-1 and 2. In addition, Compact Advanced Payload for Wide-swath (CAP-W), capable to providing of the wide swath Electro-Optical (EO) images, is successfully designed to satisfy the required mass and power budget for the CAS500-4 applied with CAS500 standard platform. In this paper, we will describe critical design results of the CAS500-4 and the plan for the next year.

[P-59] Database Structure Design for Mass Property Management in Satellite Development Programs

Hong-Youl Moon

Korea Aerospace Research Institute

The mass property database is managed in various ways depending on the experience of the engineer in charge of the mechanical design of each satellite. The mass properties of the satellite can be managed by using its own function provided by 3D CAD S/W or by MS Excel or by developing in-house tools within the company. However, there is currently no mass property management tool developed in consideration of user convenience in the domestic satellite development program. In addition, it is difficult to perform mass property management only with the functions provided by 3D CAD S/W. Therefore, Excel is mainly used to manage the mass properties, but if the basic functions provided by Excel are used, many problems may occur and it can be a time-consuming task. In this study, a method for managing mass properties using Excel to minimize human error and human resources is proposed. By identifying requirements for database structure design and implementing it using Visual Basic Application (VBA) as well as Excel internal functions, it is possible to minimize human errors in data input and to automatically extract mass property values in the desired form.

[P-60] Final Alignment of KPLO FM

Seung-Yong Min, Hyun-Jin Shin, Beom-Suk Kang, and Ju-Hyun Kim

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO) was launched in August, 2022. KPLO has six payloads including optical cameras such as LUTI and ShadowCam. KPLO also has sensors and actuators to control the attitude of KPLO, and antennas to communicate with the Ground station on the Earth. Alignment of some payloads, sensors, actuators and antenna of KPLO were performed at specific phases during KPLO AIT. In this paper, alignment test configuration and schedule are described. Alignment overview and final alignment results of KPLO FM are also summarized.

[P-61] X-Band Antenna Angular Profile Generation and Validation for Low Earth Orbit Satellite

Kyun-Sang Park

Korea Aerospace Research Institute

In the low earth orbit satellite, the directional antenna is mostly used for the high-speed image data transmission to the ground station. Thus, it is necessary to point for the directional antenna to the ground station within the effective beam coverage. The directional antenna has two-axis gimbal mechanism with the angular velocity constraint. In order to validate the antenna pointing to the ground station, the azimuth and elevation angular profiles of the antenna are generated with considering the angular velocity constraint. Finally, MATLAB simulation and the interface verification using the dedicated software are conducted.

[P-62] Development of Electric Thruster Simulator for Satellite AIT

Keun Joo Park, Su Kyum Kim, Hyoung Yoll Jun

Korea Aerospace Research Institute

GEO-KOMPSAT-3 (GK3) satellite equipped with electric propulsion subsystem (PS-E) is being developed since 2021. To implement the PS-E in GEO satellite, series of ground verification tests shall be performed during satellite AIT process. Due to the constraints in actual PS-E test environment, a thruster simulator will be developed and applied in the required tests. In this paper, the functional requirements of the thruster

simulator are identified. Also, the application plan of the thruster simulator is described.

[P-63] Collocation Capacity of Geostationary Satellites in 128.2 ± 0.1 deg.E Station-Keeping Box

Bong-Kyu Park

Korea Aerospace Research Institute

At present, three Korean geostationary satellites are performing their missions at longitude of 128.2 ± 0.1deg.E; COMS alone at 128.15 ± 0.05 deg.E., and GEO-KOMPSAT-2A and GEO-KOMPSAT-2B in collocation at 128.25 ± 0.05 deg.E. In the near future, additional geostationary satellites are expected to join at same longitude. For example, GEO-KOMPSAT-3 with hybrid propulsion system will be launched in 2027 at longitude of 128.15 ± 0.05 deg.E. It is easily expected that as the number of satellites increases, the risk of collision between the satellites increases. In an effort to support the proper scheduling of satellite programs, this paper introduces the analysis results on the maximum number of acceptable geostationary satellites in 128.2 ± 0.1 deg.E taking into account the type of propulsion system which gives impact on the collocation accuracy.

[P-64] Aliveness Verification of Flight Model Solar Panel with Illumination Test

Sung-Woo Park, Hee-Sung Park, Hyung-Jin Kim

Korea Aerospace Research Institute

A solar array panel generates primary power for satellite during sun period. The generated power is provided to satellite bus and payload system for their operations and the remaining energy is used for battery charging to provide power during eclipse period and insufficient solar panel generated power even during sun phase. For the best performance provision of the flight model solar generator during in-orbit mission operation, it is very necessary to check and verify the health status of the cells and string of solar panels periodically during on-ground storage and after performing major system level tests or mechanical activities performed with installing flight model. The illumination test is performed using light source and the output current of each string will be recorded during tests. And, the test will be conducted on a separated panel basis. In this paper, test preparation, methods and results performed with flight model solar panel for LEO satellite are summarized and presented.

[P-65] The Manufacturing of Infrared Heating System for GEO Satellite FM Thermal Vacuum and Balance Test

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

[1]*Korea Aerospace Research Institute*

[2]*Hanyang ENG*

The performance of satellite must be verified under the space orbit environment before the launch. The infrared heating system surrounded satellite create thermal environment to satellite using radiation. Because satellite have recently become larger for high performance, the design and manufacturing of infrared heating system have technical difficulties. This paper described the manufacturing results of infrared heating system designed considering satellite shape and test fixture.

[P-66] Design and Implementation of Telecommand Verification Tool for Geostationary Satellite

Su-Hyun Park

Korea Aerospace Research Institute, KARI

KARI has been developing both Low-Earth Orbit (LEO) and Geostationary (GEO) satellites. The spacecrafts communicates with the ground station via Telecommand (TC) and Telemetry (TM). The ground station sends TCs to operate the spacecraft, to perform the mission, and to recover from the spacecraft failure. The spacecrafts gathers the spacecraft bus and payload status and transmits them to the ground station via TM. In order to develop and to verify the TC functions for GEO satellites, it is required to imitate a ground station which creates and send TCs to the spacecraft. A TC verification tool for LEO satellite has already been developed, but the TC protocol for GEO satellites are different from that of LEO satellites. In this paper, we explain the difference between the TC protocols of LEO vs. GEO satellites. We also introduce how the TC verification tool is designed and implemented for GEO satellites.

[P-67] Pointing Analysis of a Telecommunication Satellite

Jong Seok Park, Keun Joo Park, Hyoung Yoll Jun

GEO-KOPSAT-3 Program Office, KARI

Pointing is one of most important system variables in telecommunication satellite design thanks to its close connection with payloads' service coverage as well as spacecraft performance. From the beginning of the satellite development, the pointing allocation is required to be reflected in the payload antenna design and the spacecraft attitude control system design.
A worst-case approach has been taken to predict the pointing performance based on per-axis errors defined in terms of four temporal categories, and those errors have been summed to assess the overall pointing performance.

This paper estimates the each pointing accuracy of the payload antenna boresight for a telecommunication satellite equipped with two deployable reflectors at East/West sides and two fixed array antennas on earth deck. And it is discussed the pointing analysis results compared with other commercial telecommunication satellites.

[P-68] Technical Management Plan for the Small Satellite Development

Jong-Oh Park, Yong-Sik Chun

Korea Aerospace Research Institute (KARI)

In Korea, many and various satellites from large to cubesat were developed for various demand from 1994. Korea Aerospace Research Institute (KARI) were developed from small to large satellitez for public demand such as Korean peninsula observation for territory management, agriculture and forestry management, disaster monitoring, meteorological and ocean observation and Lunar exploration etc.
For these purpose, KARI were developed Arirang series satellites to observe the earth, Cheollian series satellites to observe meteological and ocean, medium grade CAS500 series satellites for earth observing, small grade STSAT series satellites for earth observing and sciences.
Recently, many small satellites about 100 kg grade are developing for various purpose with constellation.
In this paper, we will briefly present the current technical managements to develop many small satellites simultaneously with cost effectively.

[P-69] Trend Analysis of Earth Magnetic Filed by Three-Axis-Magnetometer (TAM) on Satellite during Ground Test Period

Jooho Park, Junwon Son, Youngwoong Park

Korea Aerospace Research Institutegy

Satellite equips many sensors to carry out mission successfully. Three-Axis- Magnetometer (TAM) is one of sensors that satellite generally adopts. The sensor is installed on satellite's body properly, and it can measure earth magnetic field. Because the sensor is three-axis-orthogonal property and sticks on the spacecraft's body, the measurement value from the sensor is always different whenever the spacecraft's attitude changes. Therefore, we sometimes utilize root sum square (RSS) method for the magnitude of earth's magnetic field. This paper shows RSS value trend during the ground test period. From the result, we can figure out the relationship between earth magnetic field's magnitude and test location.

[P-70] Fault Management Design for Electrical Power Subsystem of the Next Korean SAR Satellite

Hong Won Park

Korea Aerospace Research Institute

This paper presents a detailed fault management design and its verification results for Electrical Test Bed (ETB) and Flight Model (FM) of Electrical Power Subsystem (EPS) of the next Korean Synthetic Aperture Radar (SAR) satellite, respectively. As the fault management is very important to the design, development, and operation of all satellite systems, it includes capabilities that enable the satellite systems to autonomously detect, isolate, recover and react to failure situations that interfere with their originally designed operations. Especially, we focus on the fault management design from the perspective of the satellite power system and specifically, we verify functions such as logging, survival and safing under the condition of various anomalies of EPS according to an internal fault management document.
Due to the limitation of fault injection in ETB and FM based on heritage program experience, it is noted that some out of test results in ETB such as battery cell failure fault and voltage compensation test replace the results of the FM fault management.
In conclusion, the paper showed that the fault management for the EPS of the next Korean SAR satellite is well designed as intended and verified its functions by checking the logic and the hardware after injecting appropriate faults corresponding to each test item and the test model, ETB and FM.

[P-71] Changes of Electrical Ground Support Equipment (EGSE) according to the Payload of Low Earth Orbit (LEO) Satellites

SuWan Bang[1], Hyoungho Ko[2]

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

The Low Earth Orbit (LEO) satellite developed in Korea is the Korean Multi-Purpose Satellite (KOMPSAT). From optical satellites to payloads using SAR payloads, satellites have been constructed and developed for various purposes and are currently performing missions.
As the payload is diversified according to the development of satellites for various purposes, the EGSE of satellites must also change. The EGSE should be developed to realize the test requirements required for this mission purpose. For example, it should be developed to verify and test whether the satellite can properly supply power to the changed payload through the satellite test. In addition, if the power requirements of the satellites change due to the performance improvement of the

payload, the EGSE should be developed accordingly.
This paper discusses the necessity and method of changing the payload according to the mission purpose of the satellite and the design change of the EGSE accordingly.

[P-72] Attitude Orbit Control Mode Design for On-Orbit Servicing Satellite

Kwangyul Baek, Yunju Na

Korea Aerospace Research Institude

This paper introduces overall guidance, navigation and control scheme and attitude orbit control system (AOCS) mode for on-orbit servicing spacecraft with robot manipulator. Servicing spacecraft enables stand-alone operation, rendezvous, docking and rigid connection to the client spacecraft, servicing with robot manipulator and safe escape from the client spacecraft. The AOCS modes are defined to achieve requiring on-orbit servicing functionality and AOCS actuators/sensors and proximity operation sensors/actuators are identified for each AOCS mode.

[P-73] Data Transmission in UDP and Non-IP Methods

Hyun-Chul Baek, Tae-Gun Son, Jae-Hyoung Park, Myung-Shin Lee

Korea Aerospace Research Institute

Network separation protect internal networks and systems from harmful external traffic flows such as viruses and hacking. While network separation enhanced general security, the operation procedures of security USB-based or one-way data transmission between the internal control network and external information networks decreased, along with work efficiency. The Bi-direction data transmission system was established to transmit data between two different networks to address these problems. The initial data transmission required only a minimal transmission rate. However, as large-volume data transmission was necessary, the data transmission method based on the TCP, UDP, and Non-IP methods was also tested.
The Transmission Control Protocol (TCP) transmits data in a message format, and it adopts the virtual line that sets the logical path to transmitting packets between the sender and receiver. In this case, the TCP's transmission rate is lower than the UCP's, while the reliability is secured through flow control and congestion control. The User Datagram Protocol (UDP) transmits data in the unit of the datagram and involves no step of connection or disconnection since it is a connectionless type protocol and involves no logical path either. Therefore, its data transmission rate is higher than the TCP's but its reliability is not secured. Non-Internet Protocol (Non-IP) networking is designed to complement the TCP/IP's disadvantages and support various services efficiently based on the 5G telecommunication system.
This study includes experiments to transmit data in the UDP and Non-IP setting through the 1Gbps transmission line with secured data integrity. In the UDP experiments, the transmission rate was 100 Mbps in the low-volume section and 200 Mbps in the large-volume section. In the experiment using Non-IP networking, the transmission rate was 100 Mbps in the low-volume section and 600 Mbps in the large-volume section. Compared with the UDP experiments, the integrity test of the hash function was performed only once in the initial step. After that, the test was performed when the file was executed or loaded onto the memory so that no CPU load was involved. In addition, the multi-thread support function was utilized.

[P-74] A Comparison between Palau TLM Station Actual Antenna Drive Data and GPS Location Base Angle Data during the KSLV-II Second Launch Mission

Dong-Young Shin

Korea Aerospace Research Institute

The Central Data Processing System (CDPS) in the NARO space center provides tracking aid data which is called slaving data for tracking systems. Slaving data is made from RADAR, EOTS, INS, and GPS data that is measured by various methods. Also, slaving data includes range, elevation, and azimuth (REA) data which indicate the launch vehicle position at an installed location of the tracking station. It is very important to minimize the difference between slaving data and actual antenna drive angles of the tracking system because slaving data is used when the tracking system missed a target temporally. In this paper, we present a difference between the actual antenna drive angle data of Palau TLM station and GPS location base angle data during the KSLV-Ⅱ second launch mission to find a method to reduce the difference between slaving data and actual drive angles of tracking systems.

[P-75] Current Development Status of SLR Systems Registered in ILRS and Current Status of SLR Stations in Korea

Seok-Min Song[1,2], Mansoo Choi[1], Yu Yi[2]

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

Satellite Laser Ranging (SLR) is a system that accurately measures the distance to a satellite by measuring the bidirectional Time of Flight between the pulse emitted from the laser transmitter of the ground station and the pulse emitted from the Laser Retro-reflector Arrays (LRAs) of the satellite orbiting the earth. This laser ranging technology has so far

contributed to the study of tectonic plate motion, crustal deformation, Earth rotation, Earth's gravitational field, satellite orbit determination and prediction, and satellite rotation. Recently, attempts have been made to acquire satellite images using adaptive optics together with SLR, and efforts to measure the distance of Space Debris by firing stronger laser have been continuing. For the above purpose, SLR systems are being operated in countries around the world, and this is forming an international cooperation system through the International Laser Ranging Service (ILRS). As of September 2022, there are 45 SLR stations registered and operated (Active Station) with the ILRS, and 12 more stations are expected to be completed and registered with the ILRS by 2027. We would like to review the development status of some major observatories among the SLR stations being developed around the world and introduce the SLR stations possessed by Korea.

[P-76] Development of the Solid State Telescope Instrument for Measuring Electron Microburst Precipitation in the SNIPE Mission

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

Korea Astronomy and Space Science Institute

Microbursts are the short duration (~one second) bursts of relativistic energetic electrons precipitating from the radiation belts. Microbursts are thought to be caused by chorus waves produced by equatorial plasma instabilities. The Solid State Telescope are developed to measure energetic electrons in the energy range of 100–400 keV with the geometrical factor, G = 0.02 cm^{-2} sr^{-1}. The instrument have a two-direction view; one is parallel direction and the other is perpendicular to the geomagnetic field. They have the energy resolution of within 10 % (ΔE/E) and the time resolution of within 0.01 s. The SST instruments are developed and performed energy calibrations using radioisotopes. In this time, we will briefly present the current status in development and calibration of Solid State Telescope instrument.

2부 발표시간 : 10월 28일(금) 9:40~11:00

[P-77] Preliminary Thermal Design of GrainCams for the Study of the Lunar Dust Characteristics

Dukhang Lee[1], Bongkon Moon[1], Dae-Hee Lee[1], Seonghwan Choi[1], Jihun Kim[1], Minsup Jeong[1], Jehyuck Shin[1], Chae Kyung Sim[1], Seul-Min Baek[1], Young-Jun Choi[1,2]

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

GrainCams is a suite of two light field cameras mounted on a lunar rover. The cameras, called SurfCam and LevCam, are designed to study the characteristics of the upper lunar regolith and levitated dust grains on the Moon, respectively. Despite the extreme lunar thermal environment, we designed GrianCams to provide the best performance within the operating temperature range using passive and active thermal control techniques such as thermal insulation blankets, radiators, and heaters. In this paper, we present the recently-updated preliminary thermal model that satisfies the temperature requirements in the worst cases and also suggests the required heater power based on the thermal analysis results.

[P-78] Statistical Study of Low Energy Ions Originated from the Dayside of the Moon in the Geomagnetic Tail

Jaehee Lee[1], Khan-hyuk Kim[1], Seul-Min Baek[2], Ho Jin[1]

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

We have studied the statistical properties of low-energy ions originated from the dayside of the Moon using two-year (2008–2009) Kaguya data during intervals when the Moon was in the terrestrial magnetotail lobes. These lunar origin ions were detected in the energy range of 20–2000 eV when the Kaguya was on the dayside of the Moon at ~100 km altitude. They are mostly distributed in a range of 30–120 degrees to the background magnetic field. In order to understand the source mechanism of the lunar origin ions, we examine the relationship between energy and pitch angle and between energy and solar zenith angle. We also examine whether the lunar origin ions occur in a localized region on the dayside of the Moon and the species of the individual ions by time-of-flight (TOF) data to identify a source region of the Moon-originating ions.

[P-79] Research on Test Facilities for Verifying the Performance of the Lunar Lander

Jong-Won Lee, Chun-Woo Lee

Korea Aerospace Research Institute

Recently, the most popular planet in space exploration is the moon. Many lunar exploration projects are plannngd by NASA, JAXA, ESA, ISRO, and CNSA. The purpose of this projects is to construct a lunar base for economic activities on the moon or manned exploration of Mars. In 2016, South Korea started the development of a lunar orbiter. It is successfully launched on August 5, 2022. Currently, the satellite is going to the moon. In Korea, many spaceceaft performed missions in orbit, but now We need another challenge for the purpose of exploring the surface of the planet. That's the lunar lander.
The countries that have successfully landed on the moon are the United States, China and the Soviet Union. In the 20s, India and Israel attempted to land on the moon, but failed. Therefore, facilities is necessary to verify performance of lander. There are Only the USA and China for the test facilities of lunar lander, and these countries have successfully landed on the moon.
In this presentation, we will talk about the test facility for verifying the performance of the lunar lander. There are two test facilities: an obstacle detection and avoidance facility & a landing stability and impact facility.

[P-80] Spacecraft Magnetic Interference Analysis of KMAG Observations in the Interplanetary Region

Junhyun Lee[1], Ho Jin[1], Khan-Hyuk Kim[1], Hyeonhu Park[1], Wooin Jo[1], Yunho Jang[1], Hyeonji Kang[1], Eunhyeuk Kim[2], Jo Ryeong Lim[2]

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

The KPLO-MAGnetometer (KMAG) consists of tri-axial fluxgate magnetometer sensors inside the 1.2 meter boom onboard the Danuri (also known as the Korean Pathfinder Lunar Orbiter, KPLO) to observe the near-lunar environment's magnetic fields. The three sensors (KMAG1, KMAG2, & KMAG3) are installed at different distances from the spacecraft body.
The KMAG boom was successfully deployed 4 hours after launch on 5 August 2022, and then immediately started to observe the magnetic field. In the process, Danuri passed through the edge of the geomagnetic region to the interplanetary region. In this study, we compare KMAG data to the interplanetary magnetic field from the DSCOVR satellite and also investigate differences for each sensor to check the data accuracy. The magnetic field variation observed from the KMAG shows a similar tendency with time-shifted DSCOVR data around the Lagrangian point (L1), but the magnitude is different. In

addition, each sensor in the KMAG measures different magnetic field magnitudes for each direction. In general, the measured magnetic field can be varied by the external field, the disturbed field by the spacecraft, and the offset of the magnetometer. We expect the magnetic disturbance generated from the spacecraft body in spacecraft maneuver to be more significant than other effects. The KMAG data shows a sudden change related to two-time spacecraft maneuvering periods on 6 and 7 August 2022. In the case of eliminating the external field source except for the spacecraft maneuvering effect, the magnetic field magnitude for each sensor tends to depend on the distance from the spacecraft body. In this paper, we will present the initial results of the KMAG data and discuss the significant cause of the disturbance to measure the magnetic field.

[P-81] Observation of Asteroid (65803) Didymos Using KASI Facilities in Support of NASA's DART Experiment

Hee-Jae Lee[1], Myung-Jin Kim[1], Hong-Hyu Moon[1], Young-Jun Choi[1,2]

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

NASA's Double Asteroid Redirection Test (DART) will be the first space experiment to demonstrate asteroid impact hazard mitigation by using a kinetic impactor. On 26 September 2022, the DART spacecraft will impact the satellite (known as Dimorphos) in the (65803) Didymos system, a binary near-Earth asteroid. The impact is expected to change the orbit of Dimorphos. However, because the DART spacecraft will be destructed after impact, it is necessary that an observation campaign from Earth to be conducted confirm the Dimorphos's orbital change through momentum transfer. Therefore, we planned the observation of Didymos after the DART impact using the KASI facilities including Bohyunsan Optical Astronomy Observatory (BOAO) 1.8 m telescope, Lemmonsan Optical Astronomy Observatory (LOAO) 1.0 m telescope, Sobaeksan Optical Astronomy Observatory (SOAO) 0.6 m telescope, and the Optical Wide-field patroL Network (OWL-Net) 0.5 m telescopes. In this talk, we will present the preliminary result of our observations with the future plan.

[P-82] Study on Surface Heat Transfer to Lunar Rover for Concept Study

Jong Tai Jang, Jin-Won Kim

Korea Aerospace Research Institute

Space robotics is the new coming technology area for future innovation and the sustainability of society. Planetary robots like lunar and Mars rovers need autonomous robotic technologies but also the survivability in lunar and planetary extreme environment is important. Lunar surface environment is similar to that of free space of artificial satellite systems in that it has thermal vacuum condition. But an important and additional condition is that the lunar surface affects much the temperature change of rovers because surface soil has big specific heat and mass so it acts as a major heat source on rovers with the Sun. Therefore, the thermal design should consider the surface heat of the soil additionally to the conventional thermal design of satellites. The paper describes the surface heat transfer model to rovers, its calculation equations and the result values with several assumption, which are developed in the level of concept study.

[P-83] KPLO Spacecraft Bus Operation Results for the First Trajectory Correction Maneuver

Moon-Jin Jeon, Young Ho Cho

Korea Aerospace Research Institute

After KPLO launch and Spacecraft Bus IAC was successfully completed, the first trajectory correction maneuver (TCM#1) was performed at 7 Aug. 2022. The attitude control thrusters were used for liquid settling burn. The orbit maneuver thrusters were used for main burn. Reaction wheels were used for attitude maneuver for burn attitude. The burn attitude was selected considering thrust direction, sun avoidance constraints of all optical instruments, and antenna coverage. During attitude maneuver and delta-v burn, the low gain antenna was used for communication with ground station. The high gain antenna was moved to the reference position during the burn. The TCM#1 procedure was uploaded to KPLO as absolute timed command and executed at planned time. The TCM#1 was successfully performed and KPLO is operating as planned in trans-lunar cruise phase. In this paper, we present the bus operation results for the TCM#1.

[P-84] Updated Korea Pathfinder Lunar Orbiter External Disturbance Torque Models Based on Cruise Phase Flight Telemetry

Dawoon Jung, Jae Wook Kwon, Han Woong Ahn

Korea Aerospace Research Institute

During the cruise phase of the Korea Pathfinder Lunar Orbiter (KPLO), the spacecraft experienced external disturbance torques that caused momentum to build up in its four reaction wheels. Predicting the rate of momentum buildup is important for planning excess momentum dumping using thrusters by ground command. Wheel speed telemetry during idle cruise periods in the first month of operation indicated that momentum was building up faster than simulations. As the high-gain antenna is the most significant source of solar radiation disturbance torque, our model was updated to correct the absorptivities for

our high-gain antenna model and the antenna base geometry was increased in detail to better approximate the actual conical shape. These changes improved the simulated wheel speed fit with flight data, but not completely. To account for the remaining difference, thermal reradiation torque was added to model disturbance due to heat radiation from spacecraft surfaces. The combined solar radiation pressure and thermal reradiation model is able to reproduce flight wheel speed data.

[P-85] Analysis of Spectral Difference between Crater Floors and Halos

Eunjin Cho[1,2], Chae Kyung Sim[1], Kilho Baek[3], 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 lunar surface is exposed to meteoroid bombardment and solar wind particles, being physically and chemically affected. The micrometeoroids and energetic particles create tiny metallic iron particles within the lunar soils. The impact of various-sized meteoroids not only pulverizes the surface materials but also creates craters by excavating subsurface materials and transforming minerals through the melting process. Although the crater materials were simultaneously exposed at the surface, the crater floor, halo, and ejecta show optical and spectral differences. In this study, we analyze the UV reflectance and a few space weathering parameters using VIS-NIR reflectance to compare the floors and halos in dozens of Copernican and Eratosthenian craters. We also compare the thermophysical properties of the floors and halos by using the observed surface temperature and a thermal model. This study will enhance our understanding of the crater materials.

[P-86] A Monte-Carlo Dispersion Analysis of KPLO Trajectory Correction Maneuvers for Each Launch Opportunity

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

Korea Aerospace Research Institute

Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, was successfully launched at August 4th (UTC) from Cape Canaveral, USA and is on its way to the Moon. On its trans-lunar trajectory, nine Trajectory Correction Maneuvers (TCMs) were designed to 1) make KPLO follow the design reference trajectory by cleaning up errors and 2) acquire the desired Lunar arrival condition. For the successful injection to trans-lunar trajectory, smooth operation, and $\triangle V$ budget planning, a dispersion analysis of TCMs is a key factor. This work summarizes TCM dispersion analysis for seven launch candidate dates using Monte-Carlo simulation methodology. Error sources for the dispersion analysis include launch vehicle injection error, pointing accuracy/burn magnitude error of thrusters on KPLO. The analysis identifies LV injection as the major potential error source and shows no significant difference between the each launch candidate date.

[P-87] Effects of Micro-Vibration on MTF Measurement of Electro-Optical Satellite Payload

Shinwook Kim, Youngchun Youk, Eung-Shik Lee

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

Recently, the sensitivity of the optics rapidly increased as the optical aperture of the electro-optical system (EOS) of satellite payload increased to more than 1 m. Accordingly, the difficulty of MTF measurement, a major criteria in performance evaluation, has also increased. In particular, micro-vibration present in optical alignment facilities has the greatest influence on MTF measurements. Micro-vibration is added in the form of random noise to an original edge spread function (ESF) signal when taking a knife-edge target for ESF measuring. The added noise appears as a high-frequency component in the frequency domain and changes the MTF value. In this paper, experiments were conducted through simulated ESF to analyze the impact of MTF values by micro-vibration. The experimental results showed that the MTF value could increase by up to 15.77% in the presence of micro-vibration.

[P-88] Design of Image and Header Analyzer for Satellite System Test

Youngsun Kim, Haeng-Pal Heo

Korea Aerospace Research Institute

It is necessary to develop the accurate and fast software to analyze image data since huge size of data are generated from electro-optical camera at a lot of satellite system tests. The analysis software is designed efficiently to extract the stochastic information and analysis results from them. The paper the design concepts and c++ based implementation results to handle data acquired at the satellite system tests. The software consists of header analyzer and image analyzer. The parameter for criteria can be set by input window or input files. Also image data can be shown through GUI to analyze visually. And pre-defined synthetic data can be compared by bit to bit comparison method in the software. Automatic analyzer makes the very fast and convenient analysis for huge data. Manual analyzer can access every line to see in detail. All the results from the analyzer can be stored with setting parameters and conditions.

[P-89] Design of Electrical Ground Support Equipment for the Focal Plane Unit

Young-Yun Kim, Young-Sun Kim, Jong-Pil Kong, Eung-Shik Lee

Korea Aerospace Research Institute

Electrical Ground Suppor Equipment for the Focal Plane Unit (FPU EGSE) is primarily intended to verify the functionality and output image of the FPU. FPU EGSE has the same interface as the actual system from electrical and mechanical point of view to check its function. Electrically It controls, supplies power, and receive the output image of FPU. Mechanically it has the same electrical connection type. It is equipped with a high speed image grabber to get the image from FPU without missing the data. By analyzing the acquired image data with software, it confirms whether the content is in a defined form and the basic performance of FPU, and visualizes it for easy and quick understanding. In this paper, we will briefly address the current design and its actual use.

[P-90] Development Status of Next-Generation Space Atomic Clock

Hwan-Chun Myung, Sung-Soo Jang

Korea Aerospace Research Institute

The space atomic clock is well known to be the most important component for the Global Navigation Satellite System (GNSS) performance. In general, it is composed of four parts: Local Oscillator (LO), microwave synthesizer, control loop, and physics package. Currently, three kinds of space atomic clocks are mainly used in the GNSS missions, which are Rb Atomic Frequency Standard (RAFS), Cs beam, and Hydrogen maser. According to Allan Deviation (ADEV), $1 \times e^{-14}$/ day is considered the acceptable stability requirement for the GNSS missions. Recently, many studies have been made worldwidely in order to improve the frequency stability of the space atomic clock. Among them, the paper introduces four space atomic clocks designed with the cutting edge technologies: One Clock Ensemble (ONCLE), Mercury Atomic Frequency Standard (MAFS), Optical Atomic Clock, and Atomic Clock Ensemble (ACES). Compared to the previous space atomic clock, the new ones are trying to resolve various disadvantages due to the wall collisions, the light shift, and environmental sensitivity etc. As a result, the new space atomic clocks are expected to show the better performance of $5 \times e^{-15} - 3 \times e^{-16}$/ day. The paper differentiates the four space atomic clocks, explaining features of the new technologies adopted by them.

[P-91] Analysis of the Verification Plan before the Satellite Assembly and Test of the Electro Optic Payload

Jong-Euk Park, Gm Sil Kang, Haeng-Pal Heo

Korea Aerospace Research Institute

The satellite payload of electro-optic camera goes through the development and verification process of various modules and units, and prepares for satellite integration through final design verification, assembly and ground verification tests at the payload level. Through the development, alignment, assembly and testing of large-diameter mirrors, structures, and camera electronics, EOS level assembly and testing are completed, and PDTS level composed of IDHU, XTXU, MUS, and XAA in charge of image data processing and transmission when the preparation of the device is completed, a functional test at the payload level is performed. The electro-optic payload for satellite perform many operations in various environments and conditions according to a given mission, and multi operations and operational functions are verified through ground tests. Various modules and units composing the payload have been developed by different companies, and the operation and environmental tests of individual units have been completed. In this paper, the verification process for each unit and module of the satellite electro-optic payload system to be mounted on a satellite to perform several case missions, and various verification methods performed at the payload level were analyzed. Through pre-verification through various operation check and operation inspection, it would be suggested to check the state of the payload level before assembling the satellite gun and to facilitate the development of the satellite program.

[P-92] Typhoon Hinnamnor Eye Tracking Using Optical Flow from Satellite Image

Jinhyung Park

Korea Aerospace Research Institute

The typhoon HINNAMNOR, which is super typhoon originated from the north Pacific area in 2022, landed on the Korean peninsula on September 6 and did a lot of damage.

In this paper, we discuss tracking result of the typhoon Hinnamnor's eye using optical flow algorithm.

We used the Lucas-Kanade's algorithm and the Gunner Farneback's algorithm for optical flow. Gunner Farneback's algorithm is dense optical flow algorithm which is used to detect inital point of eye of the typhoon. Lucas-Kanade's algorithm is sparse optical flow algorithm which is used to track eye of the typhoon.

We used GEO-KOMPSAT-2A AMI and Himawari-8 AHI image products for the test. Infrared 3.8 μm image from NMSC is used for experiment for AMI image. Image of IR 3.8 μm band shows small difference between night and day time. GeoColor image from RAMSDIS online is used for experiment for AHI image. GeoColor is color blending algorithm for ABI

without green band (0.5 μm). GeoColor dayside image is generated from visible/near IR bands and night side is generated from IR bands for high and low clouds imaging.
Using Gunner Farneback's algorithm, we tried to detect a point with a vector sum of 0 within a specific region as a typhoon's eye. However, due to of the movement of the typhoon removes effect of the wind speed, it shows low detection quality for point initialization.
Using Lucas-Kanade's algorithm, typhoon's eye is tracked well for both of AMI and AHI images. Since, GeoColor synthesizes day and night images, the quality of tracking in the day and night cross area was decreased. Gunner Farneback's algorithm shows better result in AMI IR 3.8 μm image product than AHI's image. When eye of the typhoon weakened in eastern Taiwan, tracking quality was decreased.

[P-93] SNR Analysis of Earth Observation Wide Field Camera

Jeeyeon Yoon, Sang-Gyu Lee, Seonghui Kim

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

In this paper, we introduce the SNR analysis method of a wide field camera for Earth observation. The camera to be analyzed is a TMA-type optical system having FOV 1°. The wavelength band uses the Visible~NIR band and is divided into five channels. In calculating the amount of photoelectrons reaching the detector, the characteristics of the observation object, the specifications of the camera, and the characteristics of the atmosphere are used as factors. In particular, the spectral radiance according to the solar altitude ange and the atmospheric transmission characteristics was calculated using Modtran. Through this, the photoelectron corresponding to SIGNAL was calculated, and only the most dominant shot noise was considered for Noise. As a result, the SNR value for each channel according to solar altitude angle and the SNR value according to the F-number of the optics design were derived.

[P-94] Spatiotemporal Patterns of the North Equatorial Countercurrent (NECC) using Products Derived from Satellite Altimetry and Scatterometer

Seongsuk Lee, Yu Yi, Yungon Lee,

Department of Astronomy, Space Science and Geology

The El Niño event, in which the equatorial sea surface temperature suddenly increases due to natural variability, is a representative atmospheric-ocean interaction phenomenon. The North Equatorial Countercurrent (NECC), which flows eastward throughout the entire Pacific region between average latitudes 3N and 10N, is a prominent component of the tropical Pacific current system. Because of almost equatorial location and eastward flow direction of NECC, it has been considered as an ocean current delivering the warmer western Pacific water to the eastern to excite the El Niño event. In order to test the wind driven and ocean surface current mediating hypothesis of El Nino event mechanism, using 27-year data of satellite observations we investigate the spatiotemporal variability of the near-surface (10 m high) wind speed (NSWS), ocean surface current, and sea surface temperature during two extreme and three moderate El Niño events. Based on the classical El Niño scenario, previous studies have explained 1997 El Niño event as the thermocline feedback by a typical Eastern Pacific (EP) El Niño, and the 2015 El Niño was considered as a phenomenon due to wind driven forcing in the form of a combined EP and Central Pacific (CP) El Niño. However, our results show that NECC streams in higher latitude band separated from the El Niño monitoring region and does not connect itself absolutely with the El Niño onset region (Nino 1 + 2, Nino 3 and Nino 4). We also demonstrate that the direction and intensity of NECC vary correlated with seasons and evolution phases of El Niño but irrelevantly with the change of the eastward NSWS intensity. Furthermore, the onset of the 2015 and 1997 El Niño, which started in the Nino 1 + 2 region, is difficult to explain by the scenario of transferring of heat accumulated in the western Pacific. Therefore, if the cause and driving forcing are not related with the wind and the current on the ocean surface, we may have to try to search other El Nino driving forcing in the subsurface of the ocean.

[P-95] Impact Analysis of Simultaneous Power Supply for Primary and Redundant Power Input of Space-Born Memory Equipment

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

Korea Aerospace Research Institute

In general, electronic equipment mounted on satellite is equipped with spare equipment due to the equipment can be damaged by harsh space environment. In special cases, both primary equipment and redundant equipment can be powered on simultaneously for providing a hot redundancy. Normally only one equipment is working and this case provides more reliability than hot redundancy. As a result of faulty operation or malfunction of certain system, redundant equipment can be switched on while primary equipment is still on. This paper contains the impact analysis results of the space-born memory equipment in this failure mode.

[P-96] Performance Verification of Optical Components for the CAP-W Payload of CAS-4 Satellite before Assembly-Integration and Test (AIT)

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

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

Compact Advanced Payload with Wide Swath (CAP-W) is Electro-Optics Camera of the Compact Advanced Satellite-4 (CAS-4) satellite. The CAP-W payload has the 5 multi-spectral channel and capability of wide range of swath width with multi-path stereo imaging by taking a national agriculture, water resource and forest images. The Optical Module (OM) of CAP-W payload consist of three mirrors. The performance verification of these optical components should be conducted before the Assembly-Integration and Test (AIT) of optical module. In this paper, the performance verification of mirrors is introduced. Finally, the results of verification are also analyzed.

[P-97] A Preliminary Study of the Space Search Coil Magnetometer

Hyeonji Kang[1], Ho Jin[1], Yunho Jang[1], Seungmin Lee[1], Junhyun Lee[1], Hyeonhu Park[1], Wooin Jo[1], Khan-Hyuk Kim[1], Jinsang Kim[2], Ik Joon Chang[2], Ickhyun Song[3]

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

In general, the fluxgate and the search coil magnetometers are used to measure DC and AC components of the magnetic field, respectively. The search coil magnetometer that has a wide measurement frequency range can measure electromagnetic plasma waves, up to tens of kilohertz different from the fluxgate magnetometer. Although it is scientifically necessary equipment, the search coil magnetometer has never been tried in the Korean space program.

In this study, we introduce the development of a space-based search coil magnetometer for space plasma wave phenomena research. For the search coil magnetometer electronics, we are developing a specific ASIC device to do on-board processing of large amounts of data sets.

The spectral range is up to 40 kHz. We expect the final Lab model will be ready by 2025.

For the preliminary study and ground test equipment model, we made a test bed which has a capable of measuring a frequency range 100 Hz to 40 kHz. The first test bed consists of a commercial 16 bit ADC which has 80 kHz sampling rate and the test bed software is operated on a windows-based PC.

In this paper, we describe an instrument requirement specification, a system architecture and initial test bed experiment discussions.

[P-98] Anticorrelation between the Primary and Secondary Eclipse Timing Variations of W UMa-Type Contact Binaries

Chun-Hwey Kim, Hye-Young Kim, Mi-Hwa Song, Min-Ji Jeong

Chungbuk National University

In recent years, Tran et al. (2013) found that the primary and secondary times of minimum lights were anticorrelated with each other in their O-C eclipse timing variations (ETVs) for short-period (mostly 0.2 d < P < 0.5 d) binary stars observed in the Kepler mission and they change quasi-periodically. These findings were confirmed by Balaji et al. (2015). They explained that the anticorrelation and its time variations were caused by the movement of continuously variable sunspots along the orbit. Thus, anticorrelation changes between the primary and secondary times of minimum lights in ETV may be another channel that provides information about the activity of cool spots on stellar surfaces.

To investigate the anticorrelation patterns of W UMa-type contact binaries, TESS photometric data of precisely measured 80 W UMa-type contact binaries with 120 s resolution were acquired and lots of times of minima of each system were determined to contruct the ETV of each system. The anticorrelation change pattern shown in the ETV of each system was modelled with simple trigonometric functions.

As a result, the anticorrelation patterns of the investigated systems were largely classified into three groups: (1) Their ETVs show clear anti-correlation and follow a theoretical model (s) (Group 1), (2) Although the ETVs of given systems show anticorrelation, but do not clearly follow the theoretical model (s) (Group 2), The ETVs of given systems show no anticorrelation between the primary and secondary timings (group 3). We examine how the anticorrelation morphology of these three groups is related to the change of the light curve, and furthermore, how it is related to the motion of stellar cool spots. We also discuss the existence and implications of correlations between amplitude, period, and other variables that define the anticorrelation state (mass ratio, orbital period, etc.).

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[P-99] Study on the Requirements Analysis and Design of Web Service Platform Development for Oral History Archives in the Field of Astronomy and Space Science

Yoon Kyung Seo[1], Youngsil Choi[1], Jeong-Yeol Han[1], Junghee Kang[2], Jaeheung Kim[2]

[1]*Korea Astronomy and Space Science Institute*

[2]ITTogether Co.,Ltd.

Since 2017, the Korea Astronomy and Space Science Institute has been conducting oral recordings of former heads of institutions and related academic elders. The oral records collected by this process need an oral archive system to preserve and manage the oral history archives and provide safe public services through classification, organization, and digital work. This study covers the requirements analysis and design required to develop a web-based online platform for oral history archives. A metadata management system was built to manage historical data efficiently, and a responsive web user interface and user experience were applied for user convenience. An open-source search engine was adopted to provide search features, with the database complying with national standard guidelines, and the architecture considering web accessibility, compatibility, and standardization. The users could access the oral history archives without damaging the contents through an online service platform, which will be used as a communication tool for answering questions about donated historical records and understanding oral subjects in advance. It will also help establish a method for producing oral recordings by the Korea Astronomy and Space Science Institute and a work process for managing digital oral records.

[P-100] KMAG On-Orbit Data Temperature Calibration

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

School of Space Research, Kyung Hee University

KMAG has three fluxgate magnetometers inside a 1.2 meter boom. Each fluxgate magnetometer has its own temperature sensor and two more temperature sensors which are located inside the magnetometer's guide structure are used to monitor for the inside boom structure and S/C monitoring items.
KMAG was carried out many performance tests on the ground, such as linearity, offset, noise, and temperature characteristics, etc. In particular, the KMAG fluxgate sensor has a temperature variation characteristic. Therefore, temperature calibration is one of the major calibration items of the KMAG payload instrument.
In the case of the ground test, we did the temperature characteristics test in two ways. One is a small variance test such as a small temperature increase range only using a halogen lamp in a magnetic shielding chamber. The other is large variance test using halogen lamps and LN2 in the vacuum chamber. In both of the two kinds of tests, the temperature coefficient was shown as below 0.1%/℃(= 0.2 nT/℃).
During KAMG observe on the BLT orbit, we adapted themperature coefficient value to specific data set that had temperature change of about 5℃ (August 7, 2022). As result, The temperature calibrated data set shows more reasonable comparing other space science mission data (DISCOVR) at same time.
Therefore, we have adapted the temperature coefficient value to a specific data set that had a temperature change of about 5℃ (August 7, 2022).
As a result of comparing with other space science mission data (DISCOVR) at the same time, the temperature calibrated data set shows more reasonable. In this paper, we described preliminary temperature calibration results and future plan.

[P-101] CAP-W Image Extractions from Compressed CADU by JPEG Algorithm

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

Korea Aerospace Research Institute

JPEG is the one of well-known compression and de-compression algorithm for the image processing areas. Compact Advanced Payload with Wide-swath (CAP-W), the payload of the CAS500-4 satellite, also applies JPEG to meet its communication bandwidth requirements by reducing the size of CAP-W images. This paper explains CAP-W image extraction method from the CAP-W CADU, which are compressed by JPEG algorithm.

[P-102] A Real Case Analysis of On-Orbit Break-Up Debris

Saehan Song, Jaedong Seong, Youeyon Jung, Okchul Jung

Korea Aerospace Research Institute

On-orbit satellite fragments is important issue to operators for safe and stable satellite operation, since the first severe satellite fragmentation. As the number of on-orbit satellite fragments is rapidly increasing, the possibility of damaging to our satellite is also increasing.
Satellite fragments are categorized by their characteristic and satellite break-up, which is the usually destructive disassociation of an orbital rocket body, payload, or structure and so on, accounts for more than half. However, there is a lack of research and study on real break-up case. In this paper, we analyze the real case of on-orbit break-up debris for future research.

[P-103] Future Technology and Mission for SAR Satellite

Jae-Min Shin

Korea Aerospace Research Institute

According to various and high-class demands, the technology related to SAR satellite is developing fast. Mission for SAR satellite also is sophisticated gradually. Based on the advanced system of SAR satellite, the global market of SAR is growing rapidly. The level of SAR technology in domestic area is increasing in line with the trends. Worldwide trend is forward to low-cost and fast revisit-time basically under good performance. it means the satellites will be small and constellated. for the constellation, small satellites perform formation-flying. This requests lots of techniques related to sensors, actuators, tele-communications, formation control, computing & data management, tools and test-beds and etc.. especially for system-engineering part, mission & design analysis and verification by emulation environment shall be required. Also the request of future technology is that while miniaturizing at the same time, its performance shall be properly useful for special missions. nowadays mission objective also is changing form product quality to operations, finally forwarding to various applications. it means information and data from satellites can be practically used for a real life, industry, and so on as GOLDEN mission; GIS, Ocean, Land, Disaster, and ENvironment.

[P-104] Advanced Telemetry Design for Improving Satellite Operation Flexibility

Hyun-Kyu Shin

Korea Aerospace Research Institute

Telemetry is the only means for getting data from on-orbit satellites. Due to the operation environment, communication bandwidth is limited and this affects the design of telemetry. In order to transmit as possible as many data, it is common to design telemetry format as a fixed or promised one between space and ground. Table-driven design is one of the very popular approach on telemetry processing. Several tables contain the information that how to generate telemetry on the space sector and also describes the way that the ground system interpretes the downlinked data. This design is very convenient, but it lacks flexibility. There are some demand to support various functions and format of telemetry according to the mission of the satellite. This introduces an advanced telemetry design for improving satellite operation flexibility.

[P-105] Ballast Application for KPLO

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

Korea Aerospace Research Institute

KPLO has several critical main burn maneuver in the path to the moon. And lunar orbit insertion (LOI) is also very important maneuver. Generally, it is the important that cg travel for the entire maneuver phase has to be minimize to minimize the disturbance by offset between spacecraft center of gravity (cg) and center of main thrust vector. If the cg offset was minimized, use of attitude thrust will be minimized to correct the attitude of spacecraft from disturbance by the cg offset. In the KPLO, ballasts was applied to the optimize the cg position of KPLO to minimize the cg travel and disturbance torque of spacecraft. In this paper, we will introduce the ballast application for KPLO, and present the application result briefly.

[P-106] Optimization of Fuzzy Reasoning for Satellite Telemetry through Genetic Algorithm

Seung-Eun Yang

Korea Aerospace Research Institute

Satellite is complex system that is composed of multiple subsystem modules. To check the status of satellite, various telemetries are defined and transmitted to ground. Traditionally, threshold checking and trend analysis method are applied. However, those methods require domain specific knowledge and not scalable. We proposed a system that recognize anomalous state of satellite through fuzzy reasoning. Statistical feature of satellite battery telemetry is applied to set up the fuzzy rules and reasoning. The fuzzy reasoning system is constructed by triangular membership function with four linguistic value (Zero, Positive Small, Positive Medium and Positive Big). Optimization is required to enhance the performance of the system. In this paper, we describe the optimization method of fuzzy reasoning through Genetic Algorithm (GA). GA has good searching ability for solution and multiple object design is possible. We compared the abnormal state detection result before and after the optimization to evaluate the optimization process.

[P-107] Requirements for Electrical Characteristics of Loads Connected to Regulated Power System of Satellite

Jeong-Hwan Yang

Korea Aerospace Research Institute

The power system of satellite can consist of an unregulated bus or a regulated bus. In the unregulated bus power system, a battery is used as the main power source. Since the battery is close to an ideal voltage source, the voltage of unregulated bus power system varies depending on the state of charge (SOC) of the battery, but its voltage is not significantly affected by the load electrical characteristic. Meanwhile, in the regulated bus power system, the DC-DC converter is used as the main power source. Since the DC-DC converter controls its output voltage, the voltage of the regulated bus power system is kept constant. However, if the load electrical characteristic exceed the DC-DC converter performance, the DC-DC converter

cannot maintain the regulated bus power system at a constant voltage. Therefore, in the case of using the regulated bus power system of satellite, it is necessary to specify requirements of the electrical characteristic of the DC-DC converter and load in the early stages of designing a satellite. In this paper, the specifications for the electrical characteristic of DC-DC converter and load of the regulated bus power system.

[P-108] A Study on Performance Indicators for Geo-Kompsat-3 Development Project

Ji-Mo Yang, Eung-Sik Park

Korea Aerospace Research Institute

In April 2009, Geo-Kompsat-3 development project was launched as a follow-on communication satellite development project following the completion of the mission of Geo-Kompsat-1. Geo-Kompsat-3 will be promoted with the goal of strengthening national disaster and safety management systems using public disaster communication satellites and securing leading technology for future satellite communication. Implemented as a national research and development project, let us examine the results and impact of the project through its strategic objectives and performance targets, looking at the relationship between the project objectives and the problems and issues that the project must solve.

[P-109] Environmental Tests of Optical Payload SunShield

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

Korea Aerospace Research Institute

SunShield is the baffling structure of direct sun light to optical payload. It is mounted in the front end of the optical payload to carry out the baffling purpose. Long exposure of the direct sun light to the optical payload mirrors can degrade the reflectivity and uniformity of the mirrors and therefore can lead to the degradation of optical performances such as SNR and MTF. SunShield has to be designed not to obstruct the field of view of the payload and to obstruct the out of field direct sun light. The material has to selected by considering mass and stiffness. This paper introduces the design and environmental tests performed on the optical payload SunShield. Environmental tests are performed to verify the endurance of the launch vibration environment and in-orbit thermal environment. Tests procedures and results are presented in this paper.

[P-110] Verification Plan and Test Results for the RF Compatibility (RFC) Testing of the Next Generation SAR Satellite

Young-Jin Won

Korea Aerospace Research Institute

Korea Aerospace Research Institute has been developing the next generation Synthetic Aperture Radar (SAR) satellite for the high demand of high resolution radar images. First of all, the radar satellite consumes high power by operating radar equipment during the imaging operation and radiates high level RF power more than several kilo watts during the radar signal radiation. Therefore, the Radio Frequency Compatibility (RFC) testing is important verification step for the radar satellite. The next generation SAR satellite has completed all verification phases including the system level testing and the environmental testing. In this paper, the verification plan and the test results for the RF compatibility of the next generation SAR satellite are described and summarized. The verification test results show that the next generation SAR satellite are compatible for all operation scenarios considering the worst operation case in which all bus platform units are operating normally and the SAR payload electronics are operating fully for radar imaging mission.

[P-111] Power Prediction Method for LEO Satellite Solar Array Deployment Determinant Using Machine Learning

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

Korea Aerospace Research Institute

The solar array of low-orbit satellites is a significant system that generates power for satellites, and it is essential to determine whether or not to deploy them. Methods for determining whether solar array deployment is determined include estimating changes in MOI and estimating power production. The method using the double MOI change may cause errors, so it is difficult to use it as an orbital logic. On the other hand, the method of using the amount of power generation is intuitive, but it is necessary to select an appropriate reference value to determine success. In this paper, the logic to determine the success of deployment using the amount of electricity is reviewed, and a method for selecting a reference value using machine learning is presented.

[P-112] Investigation of Error in Temperature Sensor Interface Circuit for Satellite

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

[1]*Korea Aerospace Research Institute*

[2]*Korea Aerospace Industries*

The AD590 is a two-terminal integrated circuit temperature transducer that produces an output current proportional to

absolute temperature to measure to monitor the temperature of the satellite. The AD590 is available in chip form making, it suitable for hybrid circuits and fast temperature measurements in protected environments. There are three basic types of noise inherent in a data-acquisition system. The first type is transmitted noise, noise received with the original signal and indistinguishable from it. The second type is intrinsic noise, noise generated within the devices used in a circuit. The third type is induced noise: noise picked up from the outside world and coupled into the circuit. A bypass capacitor can be used to divert some of the high frequency noise current to ground. The direct current supplied by the AD590 will be unaffected by the bypass cap and will continue to flow into the 1 kohm resistor. Only the high frequency noise current will be affected. However, the use of a bypass capacitor across the AD590 with the series resistors delays in stabilizing the output current proportional to measured temperature.

[P-113] Verification of Lateral Vibration Test System for Satellite

Hee-Kwang Eun[1], Jong-Min Im[1], Jong-Hyub Jun[1], Chang-Rae Cho[1], Nam-Jin Moon[1], Hyo-Sun Park[1], Seon-Je Jo[2], Se-Hoon Jung[3]

[1]*Korea Aerospace Research Institute*
[2]*HBK Korea*
[3]*VMVTech*

For satellite systems and components, it is essential to verify the launch environment. A vibration test system is used to simulate the launch environment, and the three axial tests are performed. The lateral vibration test system consists of a shaker and a slip table. The shaker consists of an armature, body, and suspension. The slip table consists of a large table and hydraulic bearings supporting it.
In this paper, the modeling of each element for the lateral vibration test system and verification process are introduced.

[P-114] New Qualification Standard Study for Solderless Connection Assemblies

Dokyoung Lee, Guenyoung Park, Kyungchol Lee

Korea Aerospace Research Institute

Some of the space application has not standardized for newly applied process. Solderless assembies are newly requested as space application but has not been prepared.
Especially solderless connection assemblies has been studied in ESA. Stadardization has been done and published as ECSS-Q-ST-70-61.
In this paper, we will introduce new qualification standard for solderless connection asseblies in ECSS as compaired with generic soldering verification process. And we will present applicable object part how to apply verification and What is problem and difficulties in application and verification.

[P-115] System Development for L0F Data Archiving and Restoration

Guhyeok Kim, Min-A Kim, Jaeyeol Lee, Jihyeon Yim, Myung-Jun Lee, MyeongShin Lee

Korea Aerospace Research Institute

Korea Aerospace Research Institute is operating a total of five low-orbit satellites: KOMPSAT-2, KOMPSAT-3, KOMPSAT-3A, KOMPSAT-5, and CAS500-1, and additional satellites such as KOMPSAT-6, KOMPSAT-7, and CAS500-2 will be added in the future. will be operated. The raw data for all satellites in operation should be safely archived, and the archived raw image should be restored when processing the standard image.
In this paper, the basic design of the development of Data Archiving Subsystem (DAS) that archiving, restore and monitoring satellite image raw data for existing satellites and additional satellites is described.

[P-116] Planning for the Coordination of Satellite Networks in a Geostationary Satellite Program

Seorim Lee

Korea Aerospace Research Institute

The coordination of satellite networks is an international activity involving multiple administrations and organizations. Due to various circumstances, international activities can be both uncontrollable and unpredictable. The basic methods used for coordination such as face to face meetings or the exchange of correspondence letters thus carry a high risk of possible delays. Strategic planning is therefore essential to efficiently implement and complete the coordination of satellite networks. This paper looks at the submission, review, and planning process for coordination activities to provide a better understanding of the issues and difficulties involved and thereafter to be considered in order to successfully coordinate satellite networks in a geostationary satellite program.

[P-117] Precision Ground Targeting Method for VLEO Satellite Image Acquisition

Seonho Lee

Korea Aerospace Research Institute

Since Very Low Earth Orbit (VLEO) satellites operate in the range of altitude between 200 km and 300 km, their mission have advantages in terms of spatial resolution, temporal resolution, debris collision mitigation, solar radiation mitigation, and launch vehicle accessibility, However due to the increased

atmospheric drag effect compared to LEO mission, the orbit prediction error is significantly increased, which causes a series problem and a difficulty in mission planning of the ground station. In this paper, we newly propose a precision ground targeting method for VLEO earth observation satellites. This paper formulate the operation concept, system architecture, and operation time scenario for imaging time, position, and attitude re-calculation. The optimal imaging time and the optimal satellite position is determined by on-board orbit propagator prior to the original imaging time. The optimal satellite attitude is also determined by the orbital geometry using the newly calculated imaging time and position.

[P-118] Development of Integrated DIS of TCP-IP Method Using 10G Network of Image Receiving Modem

Woomin Lee, Gyeoul Lee, Myeongshin Lee

Korea Aerospace Research Institute

KOMPSAT Mission Operation Center is operating Direct Ingestion Subsystem (DIS) of KOMPSAT-3, 3A, 5 and CAS500-1. In addtion, as software technology is advanced, DIS capable of performing all image reception in one device has been developed and is in operation. While developing the DIS of CAS500-1, the development of the DIS capable of receiving all satellite image data operated was completed. Recently, due to the development of modem hardware technology, TCP-IP DIS was developed using a 10G network instead of a conventional ECL data transmission method. In this paper, upgraded the function of receiving only one polarization in the existing ECL method to research the integrated DIS that can receive image data of both RHCP and LHCP polarization in one device, and analyzed the test results for operation.

[P-119] Study on Concept of Operation for Next-Generation SAR Satellite System

Junho Lee, Juhwang Kim, Sang-Hyun Choi, Jong-Jin Jang

Korea Aerospace Industry LTD

Earth observation satellite are classified into electro-optical satellite, infrared satellite and Synthetic Aperture Radar (SAR) satellite depending on the payload. SAR satellite emit radio waves and microwaves to ground targets regardless of the weather, and combine the reflected signals to create and image. In addition, recently, due to the demand for ultra-high resolution and moving target images, the seight of satellite is increasing, and studies of operating two/multiple satellites for bi/multi static SAR image are in progress.
In this paper, research on mission orbit analysis and concept of operation for bi-static SAR satellites as a next-generation SAR satellite system are described.

[P-120] Operation Concept and Status of CAS500-1 Partial Downlink

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

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

The Compact Advanced Satellite 500 (CAS500-1) successfully launched in March 2021. Normal operation began in October 2021 after a Launch and Early Orbit phase (LEOP) for image calibration. CAS500-1 has a difference in downlink plan operation compare to KOMPSAT operation. KOMPSAT compresses and stores image data and receives the stored image at once. On the other hand, since the CAS500-1 does not compress image data, it takes a lot of time to receive the image at the ground station.
To complement this, CAS500-1 operates by applying an offset to the image during the downlink and receiving it by dividing the image. In this paper, the concept of partial downlink operation of CAS500-1 is explained and current operation status is described.

[P-121] Fundamental Research to Develop a Super Low Altitude Satellite (200-250 km)

Hyun-Su Lim

Korea Aerospace and Research Institute

Recently, interest in a super low Earth orbit (SLEO) has increased because of the high cost-effectiveness in terms of the budget and satellite development period. The satellite reported in this paper is planned to orbit about 200–250 km above the Earth's surface, which is less than half the altitude of the conventional earth observing 500–800 km LEO satellites. The most significant advantage of operating satellites in SLEO is to improve the spatial resolution of optical imaging payloads and signal quality of SAR with the reduced operation altitudes. These benefits can link to small and cost-effective development of satellites which satisfies the mass production and constellation mission required of tens to hundreds of satellites with the rapid growth of the satellite market in the new space era.
Fundamental research has been conducted on the key technologies for the development of SLEO in the aspect of ionosphere environments (atmospheric drag and atom oxygen), system configuration designs to compensate high atmospheric drag and satellite surface material erosion research caused by dense atomic oxygen in SLEO. In addition, this paper presents feasibility analysis of using Electric Propulsion to provide drag compensation to extend satellites operation mission lifetime.

[P-122] Conducted Noise Reduction by Passing through Sub-Power Distribution Unit

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

Korea Aerospace Research Institute

Satellite level electromagnetic environment test include EMC tests such as CE and RE, Launch Vehicle RF compatibility test, and RFC test to simulate RF radiation of on-board transmitters of satellite.
Conducted noise generated by the units in the satellite merges at the power distribution unit, and noise affects the other units again. System level CE test is to measure voltage and current noise at the output power line of power distribution unit, and safety margin is analyzed by comparing this measured result with the test level of satellite's conducted susceptibility test. If a unit is not powered directly by the main power unit, but by a sub power unit that relay the power from main power unit to user unit, the conducted noise generated by the unit may be decreased through the sub power unit, and the system effect is also reduced. This paper verified that conducted noise decreased through a sub power distribution unit by EMC testing.

[P-123] Introduction of Satellite Bus Platform for Korean Positioning System

Sung-Soo Jang

Korea Aerospace Research Institute

This paper describes the development of the KPS satellite platform to establish a Korean Positioning System (KPS). The KPS satellite will be planned to use the GK2 satellite platform as a heritage. The satellite structure system, power conversion and distribution system, power generation and storage system, and propulsion system of the GK2 satellite platform can be applied to the KPS satellite platform with the same specifications, but the satellite computer system, thermal and sattitude control system may be partially changed. In particular, for the GK2's main power conversion, the Airbus' 50 V PCU was used, but it is no longer produced. Therefore, the KPS satellite platform will use Airbus' 100 V power converter, so the main power of the KPS satellite platform is supplied with 100 V. However, Airbus' 100 V power converter can supply not only 100 V power but also 50 V power up to 1.4 kW. Therefore, the main electronic components of GK2's satellite platform can be used with the 50 V power bus without changing the input power device. And, the structure and propulsion system of the KPS satellite platform will also be developed based on the GK2's heritage program.

[P-124] Issues on the Satellite Operation and Data Service for Disaster Application

Gab-Ho Jeun, Myung-Jun Lee, Myeong-Shin Lee

Korea Aerospace Research Institute

Satellite is the earth information acquisition system suitable for disaster response application due to its ability of wide area data acquisition, periodic data acquisition, and non-access area data acquisition. But, data convergence and analysis technology for the disaster application and rapid data access service were insufficient.
However, with the new satellite data processing and application technologies such as AI, cloud and big data, demand for the use of satellite data for disasters application is increasing.
This paper summarizes the cases of disaster operation of LEO earth observation remote sensing satellites operated by KARI. The case of the disaster operation in this paper is intended to be used as basic data for defining satellite operation and data service processes to be applied to national disasters.

[P-125] Development and Test Operation Analysis of Multi-Satellite Downlink Scheduling System

Jung-Nam Jun, Eun-Suk Lim, Gab-Ho Jeun, Myeong-Shin Lee

Korea Aerospace Research Institute

There are a total of five satellites operated by the Korea Aerospace Research Institute and follow-up satellites will continue to launch and operate. in an effort to operate multi-satellite stably and efficiently, various operating technologies are being developed and the functions of the operating system are continuously advanced.
In this paper, we introduce the operational concept of generating a imaging and receiving mission schedule, which is the main mission of the satellite. Especially, a function for as system that automatically generates a schedule for receiving an image to the ground will be described in detail. It also summarizes the operational results tested by establishing and environment similar to the actual operations.

[P-126] Structural Analysis for Shock Test Machine in KARI

Jong-Hyub Jun, Sung-Hyun Woo, Jong-Min Im, Hee-Kwang Eun, Nam-Jin Moon, Jin Park, Chang-Rae Cho

Korea Aerospace Research Institute

The shock test is an essential process to verify the satellite components for shock environment specification. The shock environments are induced mainly by launch vehicle separation or appendages deployments like solar array and payload. The

test level has been controlled by using specific structure named as resonator to generate the characteristic frequency (1,000 or 1,500 Hz) in KARI test machine. It is not easy to simulate the test system due to the complexity of system, and the definition of plane input force. Therefore, the system feature can be estimated by frequency response function using simplified model. The finding for the test system by simulation may be very useful way to improve test technique. Now this study is for understanding the response effects by interface plate and fixture. It shows the thickness variation of interface plate has some relations with fixture response.

[P-127] A Study on the Reference Platform for Deep Space Probe

Hyeon-Jin Jeon

Korea Aerospace Research Institute

There is a variety of deep space mission, and those can be sorted into roughly 5 types such as fly-by exploration, orbiting exploration, landing & surface exploration, landing & sample returning exploration, and attachment with sample returning exploration. However, it is very burdensome and expensive to develop every unique platform for every different type of missions.

In order to minimize development cost and burden for space probes, a reference platform for deep space probe shall be derived, which can be applied commonly for mission types as many as possible.

This paper discusses the reference platform for deep space probe under practical constraints. This result can be a a good guideline for designing future space probe.

[P-128] Design of Rack for Power EGSE

Seung Won Cho, Dong-Chul Chae

Korea Aerospace Research Institute

Power Electrical Ground Supporting Equipment (EGSE) provides electrical power to low earth orbit and geostationary satellite from Assembly Integration & Test (AI&T) phase to launch campaign. Power EGSE is composed oof many units inside rack. The heat dissipation should be considered in design of rack since the active components of power EGSE emits heat during operation. Power EGSE moves also into various facilities during AIT and therefore it should be designed in order that the center of gravity is well established. In this paper, the design of the rack for the power EGSE is presented focusing on heat dissipation and center of gravity.

[P-129] An Introduction on GK3 Fault Management Preliminary Design Progress

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

Korea Aerospace Research Institute

The the geostationary orbit public complex communication satellite (GK3) is the first communication satellite being developed in Korea. System requirements were defined through the System Design Review (SDR) in April of this year, and the preliminary design is currently in progress.

Fault Management is also performing preliminary design according to the overall system development schedule. Fault Management is generally performed through the process of failure detection, isolation, and recovery (FDIR). After the system requirements defined in the system design review are assigned to the satellite requirements related to fault management, the requirements are also assigned to each subsystem. First of all, It is defined the development philosophy that can be applied to the overall fault management. If the fault management concept is defined in the operation concept document (CONOPS), the overall fault management architecture is developed. According to the concept of the architecture, faults and failures are identified by level in order to satisfy the fault management requirements. According to this series of processes, fault management has several steps to be performed and defined.

In this paper, we define the activities necessary to carry out the preliminary design of fault management and introduce the progress details together.

[P-130] Analysis of the Influence of RF Interference between Satellite Bus and Payloads of Geo-Kompsat-3

Jae-Dong Choi

Korea Aerospace Research Institute

GEO-KOMPSAT-3 Satellite has a mission to provide the national public satellite communication network, a mission to improve the navigation system's attributes such as accuracy, reliability, and availability, and a mission to collect information to prevent water disaster such as floods. Therefore, communication payloads with various frequency bands including Ka-band, S/L band, and C-band will be used to perform various public missions. But these communication payloads are not only close to the GNSS receiver and TC&R receiver used by satellite, but also have a high possibility of generating an RF interference signal because the frequency band used is very close.

In this study, payload design requirements were presented to minimize the RF interference through mutual RF emission analysis between L-band signal used in SBAS and DCS payloads and GNSS receivers and TC&R receiver inputs used in satellites.

[P-131] Verification of Reflow Soldering Process Applied to CCGA Package for Space Applications

Cho Young Han

Korea Aerospace Research Institute

The verification of a reflow soldering process, which was applied to the Ceramic Column Grid Array (CCGA) packages, was studied for satellite applications. This verification is a fundamental step to develop a new multipurpose push broom imager for space-borne cameras. The verification of the CCGA package shall be performed with a daisy chain device to demonstrate the reliable electrical function of the PCB and the CCGA package interface throughout the qualification test campaign. The PCB design shall provide the ability through test points to locate defective connections by measuring groups of connections.

[P-132] Trend Analysis of Channel-to-Channel Image Registration for MWIR Bands of GOES-16 ABI

Sungsik Huh

Korea Aerospace Research Institute

In order to generate various useful products by complex operation between multiple band images of geostationary meteorological satellites, channel-to-channel registration must satisfy subpixel geometric accuracy.

For quantitative evaluation with subpixel accuracy in channel-to-channel image registration, traditional NCC- and NMI-based image matching methods are available.

In this paper, the trend change of channel-to-channel image registration was estimated for MWIR bands of GOES-16 ABI, and it is compared with channel-to-channel registration evaluation results performed by NOAA.

The target bands are C07 (3.9 μm) and C11 (8.5 μm), where the earth surface is measured, among MWIR bands, and the annual and daily trends were analyzed.

Through the analysis, it was confirmed that the subpixel image registration method works properly in the actual geostationary satellite image.

[P-133] The Overview of Launch Site State of Health (SOH) for Satellite

Yungoo Huh, Minjun Kim, Seungwon Cho, Dong-Chul Chae

Korea Aerospace Research Institute

Many satellites have been designed and developed by Korea Aerospace Research Institute (KARI). The satellite are generally launched from abroad using foreign launch vehicle such as falcon and ariane. Therefore, it is essential and important to perform the State of Health (SOH) test of satellite at launch site after the transportation. Before the satellite are integrated into foreign launch vehicle, it need to make sure that the satellite is working properly through the launch site SOH test. the SOH tests to be performed at the launch site are split over several test groups. Each test group has its own success criteria and some test group need special test aids.

In this paper, we would like to introduce test objective, test configuration, test items, test flow, etc. That is we give a brief overview on launch site SOH.

[P-134] Preliminary Research on Simultaneous Scheduling of Satellite and Onboard Antenna

Jeonghoon Hyun

Korea Aerospace Research Institute

Earth observation satellites are operated through mission schedules to obtain the most profitable images. The observation schedules are established considering the priority of targets and mission constraints. In general, after an observation mission is scheduled, antenna tracking planning is implemented confirming if all data obtained in orbit can be downloaded to ground stations within desired timeline. If the antenna is not able to transmit the data on time, it is considered to modify the observation schedules such that the computation time is extended, which can be critical to urgent missions. In this study, preliminary research on simultaneous scheduling of satellite and onboard antenna is introduced in order to plan observation schedule and antenna tracking profile at the same time.

[P-135] Exception Image Processing Methods for Automatic Cloud Analysis of Different Types of Optical Satellite Catalog Images

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

[1]*Korea Aerospace Research Institute*

[2]*Satrec-i Imaging Service*

Multi-purpose satellite optical images provide catalog information of each image through an online-only search system by dividing the share of clouds included in the image by a defined cloud rating.

The user identifies a valid image through catalog information registered in the search system and requests generation of a standard image.

At this time, the catalog registered in the search system is subdivided into classes defined in the image (dark clouds/light clouds/cloud shadows/backgrounds) using Semantic Segmentation, a pixel-level cloud detection model, and the cloud analysis is automatically performed according to the strength of the cloud

by adjusting the weight.
However, various types of images exist in the catalog of optical satellites depending on satellite image characteristics and image processing results. Therefore, there are limitations in performing various types of catalog cloud analysis through the "AI-based automatic cloud calculation model".
In this paper, we describe the exception image processing method for automatic cloud analysis of various types of optical satellite catalog images, and analyze the results of the automatic cloud analysis system applying the exception image processing method.

[P-136] Study for Prediction Method of Atomic Oxygen Erosion Based on Data Prediction Using LSTM/SPD Methods as Opposed to the Robust Design Technique

You Gwang Kim[1], Yun Kyong Hyon[2], Suk Hoon Lee[3]

[1]*Korea Aerospace Research Institute*
[2]*National Institute for Mathematical Sciences*
[3]*Chung Nam National University*

Government-funded research institutes are working together to develop the prediction simulator of Atomic Oxygen Erosion for LEO Satellite in Convergence Pilot Study for the next Creative Allied Project of National Research Council of Science & Technology (NST). As part of this study, atomic oxygen erosion prediction was performed based on data prediction using Long-short term memory (LSTM) and Similar pattern detection (SPD) Methods as opposed to the robust design technique performed so far. In integrated space environment (Vacuum, Thermal cycling, Atomic oxygen, EUV, etc.), atomic oxygen erosion is strongly influenced by solar activity, We create a prediction empirical model to predict F10.7 and Ap indices as factors affecting solar activity, and the results of comparing the amount of atomic oxygen erosion were derived using F10.7 and Ap predicted from the mission period and orbit of the LEO satellite to be launched.
The results of this study are expected to help optimize the design of polymer materials for the outer surface of LEO satellites.

[P-137] A Study on the Change Procedure Implementation Plan through the Application of Hierarchical Analysis Method for Efficient KOMPSAT Configuration Change Management

Chul Kang

Korea Aerospace Research Institute

KOMPSAT for satellite development, it is essential to perform configuration management tasks. The configuration control task, which is one of the main tasks of CM, carries out a series of activities to control the setting of the reference point, which is the standard of CM, and the change of the existing point. In order to change the reference point, there is a decision-making part related to impact analysis and rating in the process of performing the change work procedure. Therefore, it was reviewed whether such a decision-making problem could be solved by applying the hierarchical analysis method, which is one of the multi-criteria decision-making methods.

[P-138] Ocean Surface Underneath Tropical Storms Observed by KOMPSAT-5 Satellite in 2022

Chiho Kang[1], Bohwan Choi[2], Soohyun Kim[2]

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

The roughness of ocean surface, which is driven by wind and waves, can be the source of the backscatter of the synthetic aperture radar (SAR) signal, of which can penetrates clouds and arrive at the Earth's surface and the return to the satellite at any time of day. So, ocean surface underneath tropical storms can be also detected using SAR. As a result of it, SAR system can provide information on ocean surface which cannot otherwise be obtained below the cloud with finer resolution. During 2022, there have been trials to observe ocean surface for retrieving the roughness underneath large-scale tropical storms by applying KOMPSAT-5 SAR wide swath mode. In this paper, we summerize the campaign to observe ocean surface underneath tropical storms and present resultant imagery.

[P-139] Tests and Problem Fixing of Deployable Solar Panel for 6U Cubesat

Min Ki Kim, Won Sub Choi, Jin Hyung Kim

Korea Aerospace Research Institute

SNIPE developers had some problems of deployable solar panel. Solar panel was not able to deploy and was not matched to hold and release mechanism. Flight model had the problems while test model don't. There were two main causes of the problem. First is the change of the deployment spring in the hinge of the solar panel. It is a kind of unexpected error due to failure of the shape management. Second is the vulnerabilities in the hinge design of the solar panel. Brief history of the problem fixing and suggestions of the design for the hinge is presented.

[P-140] Precise Positioning of the Field Flattener Lens for Multi-Field Focal Plane Alignment

Dongok Ryu, Goeun Kim, Seonghui Kim, Youngchun Youk, Eung-Shik Lee, Jong-Pil Kong, Haeng-Pal Heo

Korea Aerospace Research Institute

The size limitation of the high-resolution electro-optical (EO) cameras requires compact optical designs for the earth observing satellites. The optical designs of the EO camera are optimized to maximize the light collecting area for diffraction-limited performance, enlarge the focal plane area for the large field of view, and minimize the total volume of the entire optical path using folding mirrors. When integrating and alignment of the camera, this volume limitation of the optical design brings about a lack of space for placing wavefront sensing instruments at the multiple field positions of the back side of the focal plane. Relay optics and field flattener lenses are one of the solutions to this problem. This ancillary equipment to be replaced by focal plane array devices are required precise positioning for the best optical performance. We determined the uncertainties of the three different methods for measuring the position of the field lens, 1) conventional mechanical tolerance alignment, 2) autocollimation between mirror cube and theodolites, and 3) three-dimensional measurement using laser trackers. Furthermore, we present a new high precision and effective systematic measurement concept that combines the strength of the three methods.

[P-141] Design and Development of FPGA Based Master Command Panel (MCP) for Ground Flight Termination System (GFTS)

Young-Jo Bae, Jae-Hoon Jeong

Korea Aerospace Research Institute

Ground Flight Termination System (GFTS) is commands transmitting system to space launch vehicle for the flight safety purpose. Master Command Panel (MCP) is a major subsystem of GFTS which triggering user-wanted commands via command buttons. MCP also needs to, as a system's top-level equipment, monitor health status of each channels and have automatic channel switch-over function if current active channel has a malfunction. This paper presents a design and development of FPGA based MCP for GFTS in Naro Space Center.

[P-142] Implementation of IRIG-106 Standard Based SOQPSK-TG Transmitter Using USRP

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

Korea Aerospace Research Institute

SOQPSK-TG is a modulation scheme based on the IRIG-106 (Inter Range Instrumentation Group) standard for telemetry systems. This scheme has high bandwidth efficiency compared to PCM/FM by using a pulse shaping filter that allows inter-symbol interference and is used in high data rate required telemetry systems. In this paper, we implement the IRIG-106 standard-based SOQPSK-TG transmitter by using a USRP. We analyze the SOQPSK-TG modulation scheme and transmitter structure and verify the bandwidth and spectrum of the transmitted signal by using a signal analyzer.

[P-143] Uniform Light Source for Electro-Optical Camera Development

Youngchun Youk, Hyung-Yun Noh, Shinwook Kim, Jong-Pil Kong

Korea Aerospace Research Institute

A uniform light source is used to verify the optical performance of space electro-optical camera. The uniform light source system developed by KARI is designed to position the integrating sphere assembly inside a vacuum chamber with the electronics and light source residing on the outside the vacuum chamber.

The system contains a Xenon light source that is fiber fed to the integrating sphere through a vacuum sealed bulkhead.

In this paper, we present the characteristics of the uniform light source used to measure the optical performance of the electro-optical camera such as the xenon spectral output, stability, and spatial uniformity mapping.

[P-144] A Study on the Effect of Wireless Communication Device on Satellite Conductivity Test Device

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

Korea Aerospace Research Institute

Satellite electromagnetic devices should be passed radiated test and conducted test. Radiated emission tests measure signals emitted from the EUT through antennas. When conducted emission is measured, the probe is connected directly to the EUT to measure the signal induced in the test unit.

Then, if a wireless communication device is used near the instrument, noise may be unintentionally measured by the instrument. This paper shows the effect of this phenomenon according to the power of the wireless communication device and the distance between the device and the instrument through actual tests.

[P-145] An Efficient Ground Station Selection Method for Receiving Signal on X-Band Antenna

Taegyoung Lee, Chiho Kang
Korea Aerospace Research Institute

In this paper, we study the problem of ground station searching, which is to find ground stations to communicate with X-band antenna of a satellite.
Existing ground station searching methods choose a single ground station from virtual ground stations for receiving signal from the X-band antenna. The problem with existing methods is that they do not utilise the remaining virtual ground stations for receiving signal. To address the problem, in this paper, we propose a novel ground station searching method. We choose multiple virtual ground stations, each of which communicates with X-band antenna in each time unit. There is an exponential number of all possible combinations of ground stations. It is very inefficient to investigate all possible combinations.
We propose a greedy algorithm that efficiently selects a combination of ground stations. It guarantees to perform as efficiently as the existing method. From experiments, we observe that our method generally outperforms the existing method in most scenarios.

[P-146] Introduction of SpaceNet Challenge and AI-Based Flood Detection Tasks

Hoonhee Lee
Korea Aerospace Research Institute

SpaceNet has been accelerating AI-based algorithm such as deep-learning, to solve difficult geospatial problems. A total of 8 competitions have been held over the past 5 years. For SpaceNet challenge every year, the SpaceNet dataset containing very high resolution satellite imagery and high quality labels is provided as an public dataset by Amazon web service. This paper describes the characteristics and results of each competition. In addition, the main contents and progress of the flood detection competition of roads and buildings in 2022 are mainly be explained.

[P-147] Software for Monitoring Anomalous Radio Frequency Signal near Launch Site

Jaehoon Jeong, Tae-Jin Lee, Young-Jo Bae, Dong-Hyun Kim
Korea Aerospace Research Institute

Ground Flight Termination System (GFTS) is a crucial system for the flight safety of launch vehicles. Therefore, the radio frequency spectrum around the launch site needs to be continuously monitored even when there is no mission. This paper introduces a radio frequency spectrum monitoring software based on LabVIEW and its monitoring algorithm. The spectrum monitoring software is programmed on LabVIEW and it is able to manipulate the spectrum analyzer mounted on an NI PXI system. When an anomalous peak signal is detected on the monitoring frequency range, it is recognized by the monitoring software and the spectrum near the peak is zoomed in. Then the frequency and power level of the peak signal are both recorded for later analysis. After the peak disappears, the monitoring spectrum range is reset. In this way, the radio frequency spectrum near the launch site can be constantly monitored.

[P-148] Performance Analysis of OFDM for Telemetry in Multi-Path Channel

Jeong-Woo Han, Dong-Hyun Kim, Sun-Ho Kwon, Chun-won Kim, Tae-Jin Lee, Na-Gyun An
Korea Aerospace Research Institute

In the new space era, a variety of launch vehicles are used and high-speed data communication is essential due to the variety of high-quality data wireless transmission requirements of launch vehicles. High-speed wireless communication is affected by channel characteristics. In particular, delay spread due to multipath causes Inter Symbol Interference (ISI) during data transmission, thereby degrading communication performance. In the case of the Naro Space Center, the received signal quality performance in the initial stage of launch is not good due to the multipath channel between the launch vehicle and the ground tracking station.
In this paper, we analyzed the performance of the Orthogonal Frequency Division Multiplexing (OFDM) technique, which is robust against delay spread due to multi-path channels.

[P-149] Simulation and Test Results for Position and G/T of Telemetry Relay Station

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

In this paper, the equipment of telemetry relay station was installed and tested at the optimal location based on the simulation of the Naro Space Center radio environment analysis. An antenna was installed at a position where the multipath effect was the least and the line of sight was well secured. After the equipment was installed, G/T measurement and RF signal transmission and receiving test were conducted. As a result, G/T was measured as −4.82 dB/K and the receiver demodulated the PCM signal by normally receiving the transmit RF signal. Data processing system transmits a signal to Telemetry Best Source Selector after signal processing.

[P-150] Performance Analysis of RF Signal Receiving Techniques by Decommutating CRC Based on KSLV-II Flight Test

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

Korea Aerospace Research Institute

KARI launched 2nd KSLV-Ⅱ mission sucessfully on 21, June at NARO space center. During KSLV-Ⅱ launch mission, ground telemetry station received Telemetry signal. In ground station, telemetry receiver receives RF signal and processes the signal at the same time. After signal processing of receiver, IF, AGC, PCM datas are recorded on recorder in real-time. Using the recorded data, we replayed IF data from the recorder and Data Processing System (DPS) made decommutation data depends on configuration of receiving techniques. Decommutation is a process whereby a single frame stream is separated to multiple data streams after frame synchronization. When PCM datas are decommutated on DPS, Cyclic Redundancy Check (CRC) is the one of determining error detection methods. It is qualified method of detecting error on telemetry frame datas. As a results, we analyzed decommutation data by counting CRC. In this paper, we verified performance of RF signal receiving techniques using KSLV-Ⅱ recording data.

[P-151] IRIG-106 Standard Compliant Telemetry Recorder and Decoding Method of Chapter 10 Data

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

Korea Aerospace Research Institute

The Naro Space Center established the IRIG-106 standard compliant Telemetry system to acquire telemetry data from KSLV-II. Safran's Radio Signal Recorder (RSR) is one of the telemetry systems and records the various launch mission data such as IF, AGC, PCM, and IRIG-B, etc. Also, all data is recorded in the IRIG-106's Chapter 10 format. The data can replay for the post-analysis, but the method of decoding the Chapter 10 file directly for the research purposes such as channel estimation and PCM data extraction can also be considered. In this paper, decodes the Chapter 10 files using IRIG software and MATLAB, and the results are shown.

[P-152] Wavefront Error Measurement Simulation for a Telescope Using the Stitching Algorithm

Goeun Kim, Dongok Ryu, Jeeyeon Yoon, Haeng-pal Heo

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

In this paper, we propose the wavefront error measurement simulation for a telescope using the stitching algorithm. As the diameter of the primary mirror has increased, the reference flat mirror also being large. This large flat is difficult to fabricate and handle. To solve these difficulties, the stitching algorithm is one of the classic method to get a full aperture with small subaperture maps. The subaperture map is designed to cover the full apertue map, and each subapertures have different tilt and power coefficients, which is same conditions as the measurement environment. We present the simulation result the testing of 600 mm in diameter telescope with 300 mm reference flat mirror at optical design program ZEMAX.

한국우주과학회 제40차 정기총회

일 시 : 2022년 10월 27일(목) 17:00

장 소 : 라마다프라자 제주 Ramada Ballroom II

1. 정족수 확인 ····· 총무이사 정종균
2. 개회선언 ····· 회장 이 유
3. 전회의록 낭독 ····· 총무이사 정종균
4. 사업보고 ····· 총무이사 정종균
5. 학술대회준비위원회 보고 ····· 위원장 박경선
6. 편집위원회 보고 ····· 위원장 지건화, 김해동
7. 포상위원회 보고 ····· 위원장 이동훈
8. 감사보고 ····· 감사 최기혁
9. 안건 1. 2022년 결산(안) 심의 ····· 재무이사 이주희
10. 안건 2. 2023년도 예산(안) 심의 ····· 재무이사 이주희
11. 안건 3. 명예회원 추대 건 ····· 회장 이 유
12. 기타 토의 ····· 회장 이 유
13. 폐회 ····· 다같이

故 김영록 박사를 추모하며

(1977.10.14.~2022.09.25)

대한민국 최초의 달 탐사선 '다누리호' 개발에 참여한 김영록 박사가 2022년 9월 25일, 일 년여 투병 끝에 마흔여섯의 나이로 세상을 떠났다.

1996년 연세대학교 자연과학부에 입학해 천문우주학에 대한 꿈을 키우던 그는 동 대학 석사와 박사과정을 거치며 인공위성 궤도 전문가로 성장했다. 2013년 그가 사회에 첫발을 내디딘 한국천문연구원에서는 레이저를 사용해 지구 주위 인공위성의 궤도를 정밀하게 결정하는 연구를 했고, 한국항공우주연구원 달 탐사 사업단으로 자리를 옮긴 2016년부터는 다누리호의 궤도를 결정하는 업무를 담당했다. 비행역학시스템의 개발과 시험, 운영 적합성 검증뿐만 아니라, 궤적 설계에도 참여해 전이궤적과 임무 궤도에서 궤도 결정 전략을 수립하고 성능을 해석하였다. 더불어 미국 나사와 다누리 항행 분야 협력을 담당하기도 했다.

김영록 박사는 특유의 넉살과 따뜻함, 그리고 적극적인 자세로 많은 사람의 사랑을 받았다. 음악에 대한 그의 열정은 매우 커, 학부 시절 음악 밴드 'GAIA'에서 기타리스트로 활동했으며, 천문연구원 음악 동호회 '뮤직다카포' 회장을 역임하며 수차례 공연을 통해 연구원과 가족들에게 따뜻한 음악을 선사하였다. 농구와 축구에도 열심이었던 그는 축구동호회에서 꾸준히 활동함은 물론 천문연구원과 항공우주연구원이 함께 하는 농구 모임 'SPACE'를 만들기도 했다.

국내 몇 안 되는 인공위성 궤도결정 전문가로서, 그리고 음악과 운동을 사랑했던 젊은이로서 다채로운 삶을 살아가던 그가 떠난 자리는 쉽게 채워지지 않을 것 같다. 그가 헌신했던 다누리호는 그의 발인 날 지구에서 가장 멀리 떨어진 약 155만 km에 도달했고, 다시 지구로 방향을 틀어 남겨진 그의 꿈과 열정을 싣고 달을 향해 순항 중이다. 다누리 운영진은 그를 기리기 위해 다누리 운영 액티비티 중 하나를 'WOL-yrkim'이라 이름 붙였다.

20여 년간 회원으로 활동하며 누구보다 한국우주과학회에 애정을 가졌던 그를 더는 볼 수 없다는 사실이 안타깝다. 누구보다 그의 빈자리를 크게 느낄 반려자 정은정 박사와 아들 김은서, 딸 김슬아를 위로하며, 김영록 박사와 함께 했던 사람들의 추모하는 마음을 담아 이 글을 전한다.

2022년 10월 5일 한국항공우주연구원 송영주, 한국천문연구원 이우경

한국우주과학회보
제31권 2호 2022년 10월
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