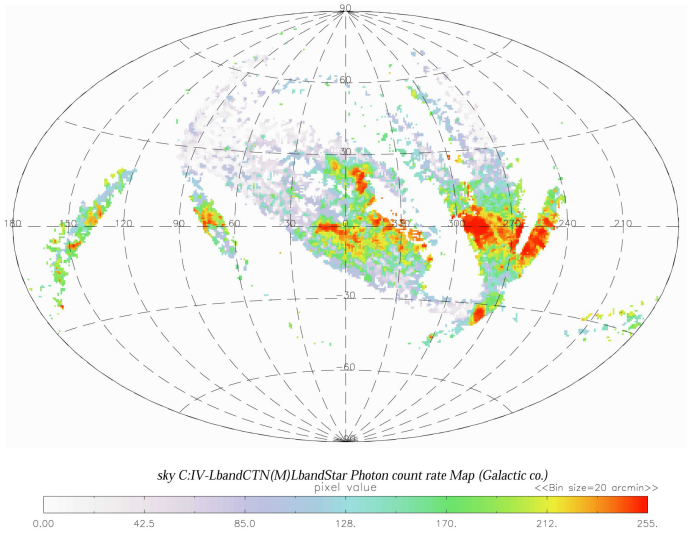
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The Korean Space Science Society

한 국 우 주 과 학 회

임 원

회 장: 이용삼 (충북대, 043-261-2314, 011-286-0174, leeysam@hanmail.net)
부 회 장: 강영운 (세종대, 02-3408-3234, 019-368-1725, kangyw@sejong.ac.kr)
총무이사: 김호일 (천문연, 042-865-3254, 011-524-4572, hikim@kao.re.kr)
재무이사: 박필호 (천문연, 042-865-3232, 016-428-3231, phpark@kao.re.kr)
학술이사: 김석환 (연세대, 02-2123-2688, 019-383-4247, skim@galaxy.yonsei.ac.kr)

이 사

민경욱 (과기대, 042-869-2525, 011-439-8617, kwmin@space.kaist.ac.kr)
심은섭 (항우연, 042-860-2470, 011-9823-7680, esim@kari.re.kr)
안병호 (경북대, 053-950-5920, bhahn@knu.ac.kr)
안영숙 (천문연, 042-865-3220, 011-9405-7741, ysahn@kao.re.kr)
이동훈 (경희대, 031-201-2449, 016-201-2449, dhlee@khu.ac.kr)
이영욱 (연세대, 02-2123-2689, 019-381-3620, ywlee@csa.yonsei.ac.kr)
이우백 (천문연, 042-865-3309, 011-9801-6919, wblee@kao.re.kr)
이 유 (충남대, 042-821-5468, 016-461-4950, euyiyu@cnu.ac.kr)
정장해 (충북대, 043-261-2313, 010-3925-2313, jeongjh@astro.chungbuk.ac.kr)
최규홍 (연세대, 02-2123-2686, 011-9733-2686, khchoi@galaxy.yonsei.ac.kr)
천문석 (연세대, 02-2123-2685, 011-9111-1947, mschun@galaxy.yonsei.ac.kr)
최용석 (전자통신연, 042-860-5263, 016-462-7036, yschoi@etri.re.kr)

감 사

양종만 (이화여대, 02-3277-2330, 019-662-2330, jyang@ewha.ac.kr)
이용복 (서울교대, 02-3475-2456, 017-204-3488, yblee@ns.snue.ac.kr)

편집위원

강영운 (세종대, 02-3408-3234)
김용기 (충북대, 043-261-3202)
민경욱 (과기대, 042-869-2525)
박장현 (천문연, 042-865-3222)
손영종 (연세대, 02-2123-5688)
이병선 (전자통신연, 042-860-4903)
정남해 (연세대, 02-2123-3439)
최기혁 (항우연, 042-860-2217)
김영수 (천문연, 042-865-3247)
김용철 (연세대, 02-2123-2682)
박상영 (연세대, 02-2123-5687)
변용익 (연세대, 02-2123-2693)
이대영 (충북대, 043-261-2316)
장민환 (경희대, 031-201-2472)
최규홍 (연세대, 02-2123-2686)

사 무 처

사무국장: 정남해 (연세대, 02-2123-3439, 016-220-3170, nhj@obs.yonsei.ac.kr)
사무간사: 신미자 (천문연, 042-865-3391, 019-574-1211, ses@kao.re.kr)

학회 홈페이지 *http://ksss.or.kr*

이 학회보는 한국과학기술단체총연합회의 일부 재정지원에 의하여 발간되었습니다.

차 례

한국우주과학회 연혁 ····· 5
20주년사 ····· 13
등록 숙소 교통 안내 ····· 19
창립 20주년기념 국제학술대회 일정표 ····· 21
발표 논문 초록 ····· 39
프로시딩 ····· 219
사단법인 한국우주과학회 정관 및 규정 ····· 385
한국우주과학회 제22차 정기총회 ····· 397
회원 주소록 ····· 409

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▣ 보낼곳: 한국우주과학회
120-749 서울시 서대문구 신촌동 134
연세대학교 천문대 내
전화: 02-2123-3439
팩스: 02-313-5033

▣ 은행계좌:
국민은행 신촌지점(012-01-0603-888)
우리은행 연세지점(126-435843-01-001)
예 금 주: 한국우주과학회

▣ 회비납부안내

회원구분	입회비	연회비
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※ 뒷면의 입회원서를 복사하여 사용해 주십시오.

(표지사진 설명)

한국천문연구원과 한국과학기술원, U. C. Berkeley에서 공동개발한 원자외선분광기 (FIMS; Far-ultraviolet Imaging Spectrograph)로 관측한 전천서베이 초기 결과로써 CIV (~1550Å) 방출선 세기의 분포를 나타낸다. FIMS는 2003년 9월 27일에 성공리에 발사된 국내 최초의 천문우주과학실험위성인 과학기술위성 1호의 주탑재체로서, 우리은하에 분포하는 고온 (수만~수백만)의 성간물질 관측을 주 목적으로 하고 있다. 추후 본 이미지의 정밀 분석을 통해 은하내부의 성간물질간의 에너지 흐름을 연구하고, 원자외선에서의 별의 catalog를 완성할 계획으로 있다.

입 회 원 서

성 명	한글		성 별	남 여	생 년 월 일	년 월 일		
	영문				주민등록번호	-		
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직장주소			우편번호		전 화		휴대전화	
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경 력								
연구 업적								

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 의하면 추천인은 본 학회 정회원이면 누구나 가능합니다).

추천인1 : 직장 및 직위	성명	(인)
추천인2 : 직장 및 직위	성명	(인)

사단법인 한국우주과학회 귀중

사무처리 사항	이사회 상정일 및 처리결과:

한국우주과학회 연혁

집행부	연도/날짜	행사내용	주최기관
제1대	1984.05.19.	한국우주과학회 창립 총회	세종문화회관
84.05. - 86.05.	1984.06.08.	제1차 이사회	연세대학교
회 장: 조경철		편집위원회 구성	
부회장: 천문석		학회지 연간 발행 회수 2회, 학술대회 2회 개최 결의	
총 무: 최규홍		학회영문 표기 제정	
		"Korean Space Science Society"	
		학회지 명칭 제정	
		한글:"한국우주과학회지"	
		영문:"Journal of Astronomy and Space sciences"(JASS)	
	1984.09.30.	국문학술지"한국우주과학회지"창간	
	1984.11.02.	1984년도 가을 학술대회	연세대학교
	1984.11.02.	"학술대회 논문초록집" 창간	
	1985.03.15.	1985년 제1차 이사회	연세대학교
	1985.04.20.	1985년도 봄 학술대회	연세대학교
	1985.04.20.	1985년 봄 학술대회 논문초록집 발행	
	1985.05.04.	제2차 정기총회	경희대학교
	1985.05.04.	1985년 제2차 이사회	연세대학교
	1985.05.04.	한국우주과학회 학술상 제정(1회 오규동회원 수상)	경희대학교
	1985.06.30.	"한국우주과학회지" 제2권1호 발행	
	1985.11.02.	1985년도 가을 학술대회	과총
	1985.11.02.	1985년 가을 학술대회 논문초록집 발행	
	1985.12.31.	"한국우주과학회지" 제2권2호 발행	
	1986.03.21.	1986년 제1차 이사회	연세대학교
	1986.05.10.	1986년도 봄 학술대회	연세대학교
	1986.05.10.	제3차 정기총회	연세대학교
	1986.05.10.	1986년 봄 학술대회 논문초록집 발행	
제2대	1986.06.20.	1986년 제1차 평의원회	연세대학교
86.06. - 88.05.	1986.06.30.	"한국우주과학회지" 제3권1호 발행	
회 장: 박경윤	1986.10.11.	1986년 제2차 평의원회	연세대학교
부회장: 박홍서	1986.11.15.	1986년도 가을 학술대회	천문우주과학연구소
김두환	1986.11.15.	1986년 가을 학술대회 논문초록집 발행	
총 무: 최규홍	1986.12 31.	"한국우주과학회지" 제3권2호 발행	
	1987.03.26.	1987년 제1차 평의원회	연세대학교
	1987.05.02.	1987년도 봄 학술대회	연세대학교
	1987.05.02.	제4차 정기총회	연세대학교
	1987.05.02.	1987년 봄 학술대회 논문초록집 발행	
	1987.06.29.	한국과학기술단체총연합회 회원 가입	
	1987.06.30.	"한국우주과학회지" 제4권1호 발행	
	1987.07.03.	1987년 제2차 평의원회	연세대학교
	1987.07.15.	편집위원회	연세대학교
	1987.08.	"제20차 국제천문연맹 회의 " 회원 12명 참석	미국 볼티모어
	1987.10.01.-10	"아시아 태평양 천문연맹 회의" 회원 8명 참석	중국 북경
	1987.10.31.	1987년도 가을 학술대회	전남대학교
	1987.	Dr.R.H.Koch (Univ.of Penna.) 초청강연	
	1987.12.31.	"한국우주과학회지" 제4권2호 발행	

집행부	연도/날짜	행사내용	주최기관
	1988.05.07.	1988년도 봄 학술대회	한국과학기술원
	1988.05.07.	제5차 정기총회	한국과학기술원
	1988.05.07.	1988년도 봄 학술대회 논문초록집 발행	
제3대	1988.06.30.	"한국우주과학회지"제 5권1호 발행	
88.05. - 90.05.	1988.07.08.	1988년 제2차 평의원회	연세대학교
회 장: 나일성	1988.09.14.	1988년 제3차 평의원회	연세대학교
부회장: 김두환	1988.10.22.	1988년도 가을 학술대회	충북대학교
김철희	1988.10.22.	1988년도 가을 학술대회 논문초록집 발행	
총 무: 최규홍	1988.12.31.	"한국우주과학회지" 제5권2호 발행	
	1989.02.10.	1989년 제1차 평의원회	연세대학교
	1989.05.06.	1989년도 봄 학술대회	연세대학교
	1989.05.06.	제6차 정기총회	연세대학교
	1989.05.06.	1989년도 봄 학술대회 논문초록집 발행	
	1989.09.11.	1989년 제2차 평의원회	연세대학교
	1989.06.30.	"한국우주과학회지" 제6권1호 발행	
	1989.10.27.-28	1989년도 가을 학술대회	천문우주과학연구소
	1989.10.27.-28	1989년도 가을 학술대회 논문초록집 발행	
	1989.12.31.	"한국우주과학회지" 제6권2호 발행	
	1990.02.19.	1990년 제1차 평의원회	연세대학교
	1990.04.14.	1990년 봄 학술대회	과학기술회관
	1990.04.14.	제7차 정기총회	과학기술회관
	1990.04.14.	한국우주과학회 공로상 (이용삼 회원)	한국우주과학회
	1990.04.14.	1990년도 봄 학술대회 논문초록집 발행	
제4대	1990.06.30.	"한국우주과학회지" 제7권1호 발행	
90.06. - 92.05.	1990.09.15.	1990년 제2차 평의원회	연세대학교
회 장: 조경철	1990.10.22.	1990년 가을 학술대회	전북대학교
부회장: 최규홍	1990.10.22.	1990년도 가을 학술대회 논문초록집 발행	
이우백	1990.11.5.-13	국제쌍성학술대회(International Colloquium on new Frontiers in Binary Star Research)	서울,대전,경주
총 무: 강영운	1990.12.31	"한국우주과학회지" 제7권2호 발행	
	1991.03.09.	1991년 제1차 평의원회	연세대학교
	1991.04.20.	1991년 봄 학술대회	한국과학기술원
	1991.04.20.	제8차 정기총회	한국과학기술원
	1991.04.20.	1991년도 봄 학술대회 논문초록집 발행	
	1991.05.11.	편집위원회	충북대학교
	1991.06.30.	"한국우주과학회지" 제8권1호 발행	
	1991.09.03.	1991년 제2차 평의원회	연세대학교
	1991.10.01.	편집위원회	천문우주과학연구소
	1991.10.19.	1991년 가을 학술대회	국립중앙과학관
	1991.10.19.	1991년도 가을 학술대회 논문초록집 발행	
	1991.12.31.	"한국우주과학회지" 제8권2호 발행	
	1992.03.10.	1992년 제1차 평의원회	연세대학교
	1992.04.	제2회 과학기술우수논문상 (김천휘 회원)	과총
	1992.04.18.	1992년 봄 학술대회	세종대학교
	1992.04.18.	제9차 정기총회	세종대학교
	1992.04.18.	1992년도 봄 학술대회 논문초록집 발행	
	1992.05.04.	제5대 임원 회의	연세대학교

집행부	연도/날짜	행사내용	주최기관
제5대	1992.06.14.	1992년 제2차 평의원회	연세대학교
92.06. - 94.05.	1992.06.30.	한국우주과학회지제9권1호 발행	
회 장: 천문석	1992.05.11.	"한국우주과학회지" ISSN 1225-052X 부여	국립중앙도서관
부회장: 오규동	1992.08.29.	1992년 제3차 평의원회	연세대학교
이동규	1992.10. 2.	1992년 가을 학술대회	한국과학재단
총 무: 김천휘	1992.10. 2.	"한국우주과학회보" 창간 제1권1호	
	1992.10. 2.	최두성 (중국장춘인공위성관측소) 초청강연	한국과학재단
	1992.10. 2.	K.Freeman (호주국립대학교) 초청강연	한국과학재단
	1992.12.31.	"한국우주과학회지" 제9권2호 발행	
	1993.02.24.	1993년 제1차 평의원회	연세대학교
	1993.02.24.	편집위원회	연세대학교
	1993.04.	제3회 과학기술우수논문상 (강영운 회원)	
	1993.04.30.	1993년도 봄 학술대회	경희대학교
	1993.04.30.	제10차 정기총회	경희대학교
	1993.04.30.	"한국우주과학회보" 제2권1호 발행	
	1993.06.11.	1993년 제2차 평의원회	연세대학교
	1993.06.30.	"한국우주과학회지" 제10권1호 발행	
	1993.09.25.	1993년 제3차 평의원회	연세대학교
	1993.10.05.-11	동양천문학 국제학술대회(주제: 곽수경으로부터 세종대왕까지의 동양천문학)	연세대학교
	1993.10.22.-23	1993년도 가을 학술대회	전남대학교
	1993.10.22.-23	"한국우주과학회보" 제2권2호 발행	
	1993.10.22.	F. R. Stephenson (Durham Univ.) 초청강연	전남대학교
	1993.10.22.	C.Y. Liu (Shaanxi 천문대) 초청강연	전남대학교
	1993.12.30.	"한국우주과학회지" 제10권2호 발행	
	1994.03.26.	1994년 제1차 평의원회	연세대학교
	1994.04.	제4회 과학기술우수논문상 (오규동 회원)	과총
	1994.05.06.	한국우주과학회 창립10주년 기념식	연세대학교
	1994.05.06.	한국우주과학회 창립10주년 기념 공로패 수여 (조경철,나일성,박경윤)	연세대학교
	1994.05.06.	제11차 정기총회	연세대학교
	1994.05.06.-07	창립10주년 기념 1994년도 봄 학술대회	연세대학교
	1994.05.06.-07	"한국우주과학회보" 제3권1호 발행	
	1994.05.06.	P. K. Seidelmann(미국,USNO) 초청강연	연세대학교
	1994.05.27.	1994년 제2차 평의원회	연세대학교
제6대	1994.06.30.	"한국우주과학회지" 제11권1호 발행	
94.06. - 96.05.	1994.09.10.	1994년 제3차 평의원회	연세대학교
회 장: 오규동	1994.10.27.-29	1994년도 가을 학술대회	충북대학교
부회장: 김두환	1994.10.27.	"한국우주과학회보" 제3권2호 발행	
정장해	1994.10.27.	하묘복(상해천문대) 초청강연	충북대학교
총 무: 강영운	1994.12.15.	"한국우주과학회지" 제11권2호 발행	
서경원	1995.03.20.	1995년 제1차 평의원회	서울교육대학교
이영욱	1995.04.	제5회 과학기술우수논문상(정장해 회원)	과총
	1995.05.03.	1995년도 봄 학술대회	서울교육대학교
	1995.05.03.	제12차 정기총회	서울교육대학교
	1995.05.03.	한국우주과학회 정관 제정	
	1995.05.03.	"한국우주과학회보" 제4권1호 발행	
	1995.06.20.	"한국우주과학회지" 제12권1호 발행	
	1995.08.25.	1995년 제2차 평의원회	신촌그레이스백화점

집행부	연도/날짜	행사내용	주최기관
	1995.10.07.	1995년도 가을 학술대회	한국과학기술원
	1995.10.07.	"한국우주과학회보" 제4권2호 발행	
	1995.10.16.-21	제2회 국제 동양천문학 국제학술대회 참가(이용삼외1)	중국
	1995.12.25.	"한국우주과학회지"제13권2호 발행	
	1995.12.26.	사단법인 설립 허가(허가번호 195호)	과학기술처
	1996.03.09.	1996년 제1차 이사회	연세대학교
	1996.05.04.	1996년도 봄 학술대회	연세대학교
	1996.05.04.	제13차 정기총회	연세대학교
	1996.05.04.	제13차 정기총회에서 정관 개정 및 시행세칙 제정	
	1996.05.04.	"한국우주과학회보" 제5권1호 발행	
제7대	1996.06.20.	"한국우주과학회지" 제13권1호 발행	
96.06. - 98.05.	1996.07.24.	과학기술처로 부터 정관변경 허가	
회 장: 최규홍	1996.07.26.	1996년 제1차 평의원회	연세대학교
부회장: 이용삼	1996.09.07.	1996년 제2차 이사회	연세대학교
안병호	1996.09.24.	제6회 과학기술우수논문상(김용기 회원)	과총
총 무: 이영욱	1996.11.02.	1996년도 가을 학술대회	한국과학기술원
	1996.11.02.	"한국우주과학회보" 제 5권2호 발행	
	1996.11.02.	Dr. Gary Heckman (NOAA) 초청강연	
	1996.11.02.	1996년 임시총회	한국과학기술원
	1996.12.20.	"한국우주과학회지" 제14권2호 발행	
	1996.12.20.	"한국우주과학회지" 특집호 발행(논문 16편)	
	1997.02.15.	1997년 제1차 이사회	연세대학교
	1997.02.15.	중장기기획위원회 구성	
	1997.02.15.	우주관측분과위원회 구성	
	1997.04.	제7회 과학기술우수논문상(한원용 회원)	과총
	1997.04.26.	1997년도 봄 학술대회	서울교육대학교
	1997.04.26.	제14차 정기총회	서울교육대학교
	1997.04.26.	"한국우주과학회보" 제6권1호 발행	
	1997.06.20.	"한국우주과학회지" 제14권1호 발행	
	1997.09.06.	1997년 제2차 이사회	연세대학교
	1997.11.01.	1997년 임시총회	동명여자정보대학
	1997.11.01.	1997년도 가을 학술대회	동명여자정보대학
	1997.11.01.	"한국우주과학회보" 제6권2호 발행	
	1997.12.20.	"한국우주과학회지" 제14권2호 발행	
	1998.02.28.	1998년 제1차 이사회	연세대학교
	1998.05.02.	1998년도 봄 학술대회	연세대학교
	1998.05.02.	제15차 정기총회	연세대학교
	1998.05.02.	1998년 제1차 평의원회	
	1998.05.02.	"한국우주과학회보"제7권1호 발행	
	1998.05.09.	1998년 제2차 이사회	연세대학교
	1998.05.09.	1998년 제2차 평의원회	연세대학교
제8대	1998.06.20.	"한국우주과학회지" 제15권1호 발행	
98.06. - 99.12.	1998.08.21.	1998년 제3차 이사회	연세대학교
회 장: 천문석	1998.10.22.-23	1998년도 가을 학술대회	충북대학교
부회장: 이용복	1998.10.22.	"한국우주과학회보" 제7권2호 발행	
강영운	1998.10.22.	Jerzy M. kreiner(Poland: Cracow Pedagogical University) 초청강연	
총 무: 변용익	1998.10.23.	시행세칙 개정 (제1장 1차 개정)	
사무국장:정남해	1998.12.19.	1998년 제4차 이사회	연세대학교
	1998.12.20.	"한국우주과학회지" 제15권2호 발행	

집행부	연도/날짜	행사내용	주최기관
	1999.04.17.	1999년도 봄 학술대회	연세대학교
	1999.04.17.	제16차 정기총회	연세대학교
	1999.04.17.	"한국우주과학회보" 제8권1호 발행	
	1999.04.30.	제9회 과학기술우수논문상(형식 회원)	과총
	1999.06.15.	"한국우주과학회지" 제16권1호 발행	
	1999.09.08.	"한국우주과학회지" 등재후보학술지 선정	학술진흥재단
	1999.09.30-10.01	1999년도 가을학술대회(한국천문학회와 공동개최)	한국천문연구원
	1999.09.30.	"한국우주과학회보" 제8권2호 발행	
	1999.09.30.	Pavel Kroupa(Heidelberg Univ.)초청강연	
	1999.10.01.	제17차 정기총회	한국천문연구원
	1999.12.04.	1999년 제2차 이사회	연세대학교
	1999.12.15.	"한국우주과학회지" 제16권2호 발행	
제9대	2000.01.12.	2000년 제1차 이사회	충북대학교
00.01. - 01.12.	2000.01.12.	과학기술상 후보 추천(나일성 회원)	
회 장: 정장해	2000.04.28.-29	2000년도 봄 학술대회	충북대학교
부회장: 김갑성	2000.04.28.-29	"한국우주과학회보" 제9권1호 발행	
민경욱	200.04.29.	교사를 위한 특별 강연회 개최	충북대학교
총 무: 김용기	2000.05.16.	2000년 제2차 이사회	충북대학교
사무국장:정남해	2000.05.19.	제10회 과학기술우수논문상 (한정호 회원)	과총
	2000.05.	중장기기획위원회 폐쇄	
	2000.06.15.	"한국우주과학회지" 제17권1호 발행	
	2000.	웹서버 구축 (http://ksss.or.kr)	
	2000.	ADS에 "한국우주과학회지" 논문초록 등재	
	2000.08.17.-26	우주정보소년단 지도자 천문연수-과학대중화사업	충북대학교
	2000.08.21.	전국고교생 수학 과학 탐구경진대회'자연과학'분야 '한국우주과학회장상' 제정	
	2000.10.20.	시행세칙 개정 (제1장 2차 개정, 제2장 1차 개정, 제3장 제4장 제정)	
	2000.10.20-10.21	2000년도 가을학술대회 (한국천문학회와 공동개최)	충남대학교
	2000.10.20.	제18차 정기총회	충남대학교
	2000.10.20.	2000년 제3차 이사회	충남대학교
	2000.10.20.	"한국우주과학회보" 제9권2호 발행	
	2000.10.20.	Andrew Gould(Ohio State Univ.) 초청강연	충남대학교
	2000.11.25.	2000년 제4차 이사회	충북대학교
	2000.12.20.	"한국우주과학회지" 제17권2호 발행	
	2001.01.28.	2002년 제1차 이사회	한국천문연구원
	2001.04.27.-28	2001년도 봄 학술대회	경희대학교
	2001.04.27.	"한국우주과학회보" 제10권1호 발행	
	2001.04.27.	제11회 과학기술우수논문상(서경원 회원)	과총
	2001.06.20.	"한국우주과학회지" 제18권1호 발행	
	2001.09.15.	2001년 제1차 이사회	충북대학교
	2001.11.02.	2001년도 가을 학술대회	세종대학교
	2001.11.02.	제19차 정기총회	세종대학교
	2001.11.02.	2001년 제1차 평의원회	세종대학교
	2001.11.02.	"한국우주과학회보" 제10권2호 발행	
	2001.11.10.	"한국우주과학회지" 제18권2호 발행	
	2001.12.15.	"한국우주과학회지" 제18권3호 발행	
	2001.12.19.	"한국우주과학회지"계속평가결과 등재학술지로 선정	학술진흥재단

집행부	연도/날짜	행사내용	주최기관
제10대	2002.01.16.	학회사무실 설치(한국천문연 내)	
02.01. - 03.12.	2002.01.28.	2002년 제1차 이사회	한국천문연구원
회 장: 이우백	2002.01.28.	정남해 사무국장 추대	
부회장: 민경욱	2002.01.28.	포상위원회 구성(위원장 이용삼회원)	
이용삼	2002.03.15.	"한국우주과학회지" 제19권1호 발행	
총 무: 박필호	2002.04.04.	"한국우주과학회보" ISSN 1598-5601 부여	국립중앙도서관
사무국장:정남해	2002.04.26.	제12회 과학기술우수논문상(이수창 회원)	과총
	2002.05.03.	2002년도 봄 학술대회	전남대학교
	2002.05.03.	"한국우주과학회보" 제11권1호 발행	
	2002.06.15.	"한국우주과학회지" 제19권2호 발행	
	2002.09.15.	"한국우주과학회지" 제19권3호 발행	
	2002.10.18.	2002년도 가을 학술대회	이화여자대학교
	2002.10.18.	제20차 정기총회	이화여자대학교
	2002.10.18.	2002년 제2차 이사회	이화여자대학교
	2002.10.18.	"한국우주과학회보" 제11권2호 발행	
	2002.10.18.	시행세칙 개정 (제1장 회비규정 3차 개정)	
	2002.10.18.	학회 로고 제정(2002년 2차 이사회에서 인준)	
	2002.10.18.	2002년도 한국우주과학회 학술상(장헌영, 손영종 회원)	한국우주과학회
	2002.12.15.	"한국우주과학회지" 제19권4호 발행	
	2003.03.15.	"한국우주과학회지" 제20권1호 발행	
	2003.04.22.	2003년 제1차 이사회	연세대학교
	2003.04.22.	창립20주년기념 추진 위원회 구성(위원장 강영운 회원)	
	2003.04.25.	제13회 과학기술우수논문상(김용철 회원)	과총
	2003.05.16.	2003년도 봄 학술대회	한국과학기술원
	2003.05.16.	"한국우주과학회보" 제12권1호 발행	
	2003.05.16.	Dr. Isobe(일본 국립천문대) 초청강연	한국과학기술원
	2003.06.15.	"한국우주과학회지" 제20권2호 발행	
	2003.09.15.	"한국우주과학회지" 제20권3호 발행	
	2003.10.17.-18	2003년도 가을 학술대회	청풍리조트
	2003.10.17.	제21차 정기총회	청풍리조트
	2003.10.17.	2003년 제1차 평의원회	청풍리조트
	2003.10.17.	2003년 제2차 이사회	청풍리조트
	2003.10.17.	2003년도 한국우주과학회 학술상(이병선 회원)	한국우주과학회
	2003.10.17.	"한국우주과학회보" 제12권2호 발행	
	2003.10.17.	시행세칙 개정 (제5장 제정)	
	2003.12.15.	"한국우주과학회지" 제20권4호 발행	
제11대	2004.02.12.	2004년 제1차 이사회	연세대학교
04.01. -05.12.	2004.03.15.	"한국우주과학회지" 제21권1호 발행	
회 장: 이용삼	2004.04.28.	제14회 과학기술우수논문상(이희원 회원)	과총
부회장: 강영운	2004.04.30.	2004년도 봄 학술대회	서울교육대학교
총 무: 김호일	2004.04.30.	2004년 제2차 이사회	해오름 복고을
사무국장:정남해	2004.04.30.	"한국우주과학회보" 제13권1호 발행	
	2004.06.15.	"한국우주과학회지" 제21권2호 발행	
	2004.08.13.	창립 20주년기념 국제학술대회 준비회의	
	2004.09.15.	"한국우주과학회지" 제21권3호 발행	
	2004.10.06.	창립 20주년기념 국제학술대회 준비회의	
	2004.10.27.	"한국우주과학회보" 제13권2호 발행	
	2004.10.27.-29	창립20주년기념 국제학술대회	제주해비치리조트
	2004.10.28.	제22차 정기총회	제주해비치리조트

되돌아보는 한국우주과학회 20년사

이번 기념 좌담은 한국우주과학회 20주년을 맞이해 학회의 지난 역사를 돌이켜보고, 지난 20년이 남긴 지혜를 후배 회원들에게 남겨 주기 위해 마련한 자리이다. 그래서 한국우주과학회 창립 당시에 가장 많은 일과 고민을 나눈 분들이 자리를 함께 했다.

뿌리 깊은 나무는 바람에 흔들리지 않으며 꽃과 열매가 많이 열린다고 했다. 1984년 우여곡절 끝에 탄생한 한국우주과학회의 20년은 뿌리를 더 깊고, 더 넓게 내뻗는 과정이었다. 황무지처럼 척박한 땅과 길항하고, 소통하고, 화해하고, 투쟁하는 과정이었다. 처음 묘목을 심은 곳은 바람 많고 물 마른 곳이었지만 어느덧 토질을 변화시키면서 단단하고 우람한 아름드리나무를 성장시키는 땅이 되었다. 2004년 가을, 풍성한 수확의 계절에 지난 20년을 돌아보려 한다. 법고창신의 의지로 지나쳐온 시간을 돌이켜본 후에야 21세기 한국 우주과학의 미래를 향해 더 단단히 뿌리내릴 수 있기 때문이다.

우주과학이라는 용어 자체가 생소하던 1984년, 한국우주과학회가 시작됐다. 지금은 우주과학이 천문학만큼이나 보편적인 학문이 됐지만, 우주과학에 대한 개념이 정립돼 있지 않던 그때에 시작해서 불과 20년 사이에 우주과학의 위상은 커다란 변화를 겪었다. 한국 우주과학의 현재는 한국우주과학회의 선구적 역할이 있었기에 가능한 것이었다. 그 당시 어떻게 첨단과학인 우주과학에 첫 발을 내딛게 되었을까? 한국우주과학회 창립의 이면에는 국내외적으로 두 가지 결정적인 계기가 있었다.

첫 번째는 1983년 소련의 인공위성 코스모스 1402호가 궤도를 이탈해 낙하한 사건이다. 핵연료를 가지고 있는 상태라 해체될 때 어떤 영향을 줄 것인가가 전 세계적인 관심사였다. 그러나 그때는 미국과 소련에서 인공위성을 몇 개나 쏘아 올렸는지, 그 중에 어떤 것이 한반도를 겨냥한 것인지, 어떤 것이 군사용이고 산업용인지도 파악하지 못할 만큼 우주과학은 미개척지였다. 나일성 교수는 마침 연세대학교에 부임한 최규홍 교수를 과학기술부에 소개한다. 최교수는 과학기술부 에너지 연구소(현재 원자력 연구소)의 위성추적반 반장으로 대학원 학생들과 함께 연일 원자력 위성인 코스모스호의 궤도변화를 조사하고, 낙하지점을 예측했다. 그 일이 우주과학에 대한 관심을 촉발시켰고, 협회 창립의 한 자극제가 되었다.

두 번째 계기는 그 당시 한국천문학회가 지닌 한계 때문이다. 한국천문학회는 순수 천문학을 연구하는 단체라 새로운 학문인 응용천문학에 대한 이해도가 사람에 따라 큰 편차를 보여, 학술대회를 비롯해 마찰을 피할 수 없었다. 이런 상황은 학회의 한계와 현실을 깨닫는 계기로 작용했다.

"그러니까 인공위성을 쏘아 올리고, 세계는 급속도로 변해 가는데 어떻게 대처를 해요. 이런 마당에. 각국에서 나오는 논문을 읽으면 변화의 속도를 느낄 수 있는데 여기서는 그런 변화에 능동적으로 대처하려는 움직임이 보이지 않았어요. 여기서 천문학회를 더 발전시키기 위해 분과를 만들어 우주과학도 하자고 말을 할 수가 없더라고요. 그러니까 한쪽에선 고무적인 일이 일어나고 한쪽에선 비참했지. 두 가지 상반된 사건이 있었던 거죠."

천문석 교수는 창립 시에 가장 어려웠던 점은 우주과학에 대한 개념 정립이었다고 한다. 실제 창립 시에 우주과학이 무엇이냐는 질문과 공격을 가장 많이 받았다. 특히 천문학과 연관시키는 부분이 어려웠다고 한다.

"창립 시에는 천문학과 우주과학을 어떻게든 연관시키자는 생각들이 많았고, 그 부분에 노력을 집중했죠. 그것이 성공해서 한국우주과학회를 만들 수 있었습니다."

우주과학의 학문적 정립 노력은 결국 '천문학을 기본으로 한 우주과학'으로 의견이 모아졌다. 한국에서 새로운 학문인 우주과학, 우주천문학이 탄생되는 순간이다. 이 출발은 훗날 인공위성을 발사하는 결실을 거둔다.

한국우주과학회 창립에 뜻을 모은 후 창립 시까지 여정은 험난했다. 창립총회까지 1년이 걸렸다. 좌담회에 참가한 나일성, 천문석, 최규홍 교수는 거의 매일 만나 의견을 조율해나갔다. 서로 다른 의견이 있으면 재검토하고 조율하면서 1년 동안 거의 매일, 어떤 날은 하루에 두 번 세 번 만나면서 고민을 나눴다.

"그때의 산고의 아픔이란 것은 지난 얘기니까 이렇게 웃으면서 얘기하지 당시는 비참했어요. 이로 인해 오해도 많이 받았고, 학회를 만든 다음에 어떻게 이끌어 갈 것이냐는 걱정도 많았죠. 또 학회를 어떻게 학계로부터 인정받게 할 것인가, 어떻게 많은 사람들에게 설득을 시킬 것인가 고민을 많이 했습니다. 이것을 학문적으로 정리를 해야 되겠는데 이건 다른 선진국가에서도 따로 정리를 하지 않았거든요. 미국의 경우도 나사에서 주도하니까 끌려가는 것이었어요. 20년이란 세월이 지났고 그동안 너무 변화가 많아서 지금 생각하면 이해가 안 갈 겁니다."

천문학을 하면서도 우주에 진출하는 방향을 어떻게 잡느냐 하는 것이 굉장한 고민거리였다. 세 분 모두 천문학을 해온 사람들이라 머릿속엔 항상 모태인 천문학이 있었다. 이를 학문적으로 정립하는 데 1년이 걸렸다. 걱정과는 달리 창립 당시 발기인은 모두 50명으로 학회의 진용을 갖추기에 부족함이 없었다. 그때 많이 도와준 학술 단체가 한국기상학회였다. 그래서 오랫동안 기상학회와 함께 우호적인 관계를 유지하고 있다. 50명 발기인으로 출발한 한국우주과학회는 창립과 함께 학회지와 학술간행물의 발행, 연구발표회, 강연회 개최, 국내외의 관련 학회와의 교류 및 회의 참여, 국가의 우주산업 발전을 위한 기여 등의 사업 내용을 내걸었다.

발기인 대회 이후 1984년 5월 19일 토요일 늦은 오후 4시 세종문화회관 소회의실에서 한국우주과학회 창립총회를 개최했다. 회장은 조경철, 부회장은 천문석 교수가 맡았다. 초대 부회장인 천문석 교수는 창립총회를 연세대학교에서 하려고 했다.

"조그마한 곳에서 시작하려고 했는데 조경철 회장이 창립총회는 거창하게 하자고 해서 장소를 옮기게 됐습니다. 창립일이 그날로 결정된 것도 세종문화회관이 마침 비어 있었기 때문입니다. 주로 결혼식을 많이 하던 곳이라 오후 4시로 결정된 것입니다."

경희대 부총장을 역임한 조경철 박사를 초대 회장으로 결정하게 된 데에는 여러 가지 이유가 있었다. 즉 조회장의 지명도와 영향력, 그리고 재정적인 여력 등을 고려한 결과였다. 조회장은 창립 행사에 필요한 경비를 책임졌고 학회지를 만드는 데도 많은 도움을 줬다. 최규홍 교수는 세 사람이 창립을 준비하면서 바친 경제적 희생도 작지 않았다고 밝힌다.

"1년 동안 세 사람이 돈을 많이 썼죠. 셋이 주로 일식집인 '신호'에서 자주 모였는데, 거의 나선생님이 부담하셨죠. 그리고 교섭과정에서 여러 사람을 만날 때는 물론 발족한 다음에도 많은 경비가 소요되었습니다. 과총 등록 전까지 4-5년간 지원받을 곳이 없어서 우리가 직접 그 부분을 해결해야 했습니다. 그런 면에서 어려움이 많았죠. 아마 학회 중에서 회장을 비롯한 임원진이 우리처럼 많은 회비를 내야했던 데는 우리뿐이었을 겁니다. 한동안 임원들에게 돈을 거둬서 운영했습니다. 학회지를 만들고, 많은 진행비용들이 임원들 호주머니에서 나온 거죠."

창립총회를 연 직후 6월 8일 연세대 과학관에서 제1차 이사회를 열고 학회지 명칭을 어떻게 할 것인가에 대한 논의를 했다. 이때 학회지의 명칭을 '한국우주과학회지'(JA&SS: Journal of Astronomy and Space Sciences)로 결정한다. 학회를 만든 후에 가장 큰 과제는 과학기술단체총연합회(이하 과총)에 등록하는 것이었다. 과총에 등록해야 지원금을 받을 수 있게 돼 정상적인 학회 운영이 가능해지기 때문이다. 과총 등록의 총대를 멘 것은 최규홍 교수였다. 과총 등록의 여정은 녹록치 않았다. 1대 조경철 회장의 임기 2년 동안 등록이 이뤄지지 못했고, 2대 박경윤 회장 대에 이르러서야 등록을 하게 된다. 과총 등록이 어려웠던 것은 다른 학회의 견제로 인해 한국우주과학회에 대한 오해가 많았기 때문이었다. 그러나 사면초가의 상황에서도 한 줄기 빛은 있었다. 그때 한국우주과학회를 도와 준 분은 과총의 학회 심사위원장인 이상수 카이스트 물리학과 교수였다. 한국우주과학회 등록 시, 이교수는 세 학회에서 승낙서를 받아오게 했다. 그래서 기상학회와 측지학회에서 승낙서를 받고 마지막으로 광산지질학회에서 승낙서를 받아 이상수 박사에게 가져다줬고 이를 근거로 매우 어렵게 통과 하게 된다. 비로소 다른 학회의 견제에도 불구하고 어렵게 과총에 등록해 숙원 사업을 이루게 된 것이다.

천문석 교수는 과총 등록할 때 어려웠던 점은 무엇보다 학회 간 영역 다툼에 있었다고 한다.

"과총 등록할 때 유관 학회 3곳의 승낙이 있어야 했어요. 그래서 처음엔 천문학회와 항공우주학회, 물리학회에 승낙서를 받으려 했죠. 물리학회는 그나마 긍정적으로 나온 것 같습니다. 그러나 항공우주학회에서 승낙할 수 없다고 해서 안 됐죠. 그래서 그 당시에 우리 학회를 보고 사람들이 임의단체라는 얘기도 나왔습니다. 3년간 그랬어요."

항공우주학회도 우주과학이란 용어가 들어가니까 자신들의 영역을 침해한다고 판단했기 때문일 것이다. 하지만 그 후 사단법인 등록할 때는 항공우주학회에서 적극적으로 도와줬다. 나일성 교수는 과총 등록의 의미를 보다 실감나게 표현했다.

"학술단체가 과학과 관련돼서 창립이 되면 단체로서 공인을 받아야 하는데 공인을 못 받으면 사생아입니다. 기막힌 일이죠. 등록 사무를 과총이라는 곳에서 받습니다. 과총에서 승인을 받아야 등록증이 발행됩니다. 출생신고라 할 수 있겠죠. 그래야 등록증 사본을 가지고 연구비도 신청할 수 있었으니까요. 태어났는데 출생신고도 하지 못해 4-5년 동안 매일 걱정했어요."

제2 대에는 박경윤 박사가 회장직을 맡았고, 박경윤 회장 임기 중인 87년에 과총에 등록이 됐다. 과총에 정식 등록한 후 3대 회장은 나일성 교수가 맡는다. 그때는 아직 학회의 입지가 견고하지 못하다는 판단에서 회장을 회원들의 투표로 뽑지 않고 5명의 전형 위원이 선출했다.

1985년, 학술상을 다른 학회보다 먼저 제정한다. 당시 나일성 교수의 제의로 초대 학술상을 오규동 회원이 받게 된다. 오규동 회원의 논문은 순수하게 국산 데이터를 근거로 집필된 것으로 미국 학술지, Astronomical Journal에 실린 논문이므로 한국우주과학회의 첫 학술상을 시상한 것이다. 이후 동일한 사례가 나올 때마다 학술상을 주기로 했지만 계속 이어지진 못했다. 천교수는 당시 학술상 상금이 없어서 나 교수가 사재를 털어 지불했다고 회고했다.

1987년은 과총에 가입한 탄력을 받아 국내외적으로 많은 활동이 있었던 해이다. 우선 국제 학술 교류를 통해 학문의 폭을 넓히고 논문의 질을 향상시키고자 외국에서 열리는 학술대회에 참가한다. 미국 볼티모어에서 열린 제20차 국제천문연맹회의에 12명이 참가했으며 같은 해 10월엔 아시아태평양천문연맹회의에 참가하기 위해 북경에 갔다. 또 쌍성학계의 저명한 학자인, 펜실베니아 대학의 Koch 교수를 초청해 처음으로 쌍성연구에 관해 초청 강연을 했다. 처음 개최한 강연으로 학계의 호응이 컸던 성공적인 강연이었다. 나교

수는 북경에 갔을 때의 뒷이야기를 이렇게 전한다.

“그때만 해도 냉전시대라 중국에 가려면 안기부에 가서 교육을 받아야 하던 시절이었습니다. 그때 중앙정보부 사람을 국교수립 물밑 작전을 할 때 슬쩍 끼워서 함께 갔어요. 우리가 회의에 간 사이에 저희들끼리 별도로 이동하더라고요. 그러고 보면 우리 학회가 국교 정상화에 이바지했어요. 하하.”

제3 대를 마칠 때는 임기 동안 수고한 사람에 대한 감사로 공로상을 제정해 초대 공로상을 6년째 총무로 일한 최규홍 회원과 이용삼 회원에게 수여한다. 1대, 2대, 3대 회장 임기는 학회의 체제구축 시기였다. 이때 다른 학회들은 학회지가 정시에 나오지 않고 학회지에 논문이 없어서 걱정이었지만 우주과학회는 질 높은 논문들을 계속 실었고 매번 정상적으로 학회지를 펴냈다. 김호일 현 총무이사는 우주과학회지는 발행날짜 하나만은 정확히 지킨다고 평가했다. 젊은 회원들도 그런 성실성 면에서는 평가를 하고 자부심을 갖고 있다며 시기를 맞춰서 학회지가 정확히 나오는 점을 강조한다. 학회지의 내용은 처음엔 천문학 쪽 논문이 많았지만 천문학 관련 논문과 우주과학 관련 논문 수가 균형을 맞추다가 어느 시기에 논문편수가 우주과학 쪽이 많아지면서 역전된다.

1~3대를 거쳐 체제를 구축하고 제4 대는 학회의 체제 완성기라 볼 수 있는 시기다. 4대에 이르러 태평양 지역 학자들을 초대해 쌍성 연구의 실적을 교류하기 위한 국제쌍성학술대회를 개최한다. 이 대회에 60-70여명의 외국인이 참가, 성황을 이룬다. 이 대회를 계기로 한국우주과학회가 외국에 알려지는 큰 분기점이 됐다. 학회로서 제 궤도에 오르게 된 것이다. 또한 과총에서 시상하는 91년 우수논문상을 김천휘 회원이 한국우주학회 회원으로선 처음 받는다. 그 이후로 매년 과총의 우수논문상을 학회 회원들이 수상하고 있다.

제5 대 천문석 회장 임기에 이르러 한국우주과학회지가 심사를 통과해 ISSN 번호(1225-052X)를 국립중앙도서관으로부터 부여받아 정식으로 정기간행물로 등록돼 현재 21권 3호까지 발행됐다. 또한 이 시기에 김천휘 총무의 주도로 각 천문대의 소식과 회원들 소식, 학술대회의 논문을 요약해 실을 목적으로 한국우주과학회보를 창간했다. 한국우주과학회보는 현재 13권에 이르고 있다. 그리고 조선족으로서 만주에서 천문대장을 하고 있던 최두성 박사를 초청해 강연을 성황리에 마친다.

제6 대에 오규동 회장이 치열한 선거 끝에 당선돼 처음으로 ‘2세’ 회원이 회장으로 뽑히게 된다. 오규동 회장은 전형위원회에서 뽑지 않고 개인투표를 통해 뽑은 첫 번째 회장이다. 6대에는 강영운 총무의 주도로 과학기술처로부터 사단법인 허가를 받아 명실 공히 국가로부터 인정받은 학회로 발돋움한다.

제7 대 최규홍 회장 임기엔 향후 10여 년의 우주과학의 이정표와 그에 대비한 계획을 짜고 미래를 준비하기 위해 우주과학 중장기 기획위원회와 우주관측분과위원회를 구성했고, 1997년에 부산 동명여자정보대학에서 학술대회를 열었다. 그리고 제8 대 천문석 회장 시기에는 1999년도 가을 학술대회를 그동안 경쟁관계에 있던 한국천문학회와 공동으로 개최한다. 순수 천문학 위주인 한국천문학회와 응용천문학과 우주과학이 주인 한국우주과학회가 상생의 동반자 관계로 나아가는 첫발을 뗀 것이다. 이 해에 한국우주과학회지가 학술진흥재단 등재후보 학술지로 선정되고 제9 대 정장해 회장 임기에 이르러 학술진흥재단에 등재 학술지로 선정된다. 그리고 ADS에 한국우주과학회지 논문초록이 등재된다. 또 김용기 총무의 주도로 우주과학의 대중화를 목적으로 한 ‘교사를 위한 특별강연회’를 충북대학교에서 개최하기도 했다.

제10 대 이우백 회장 임기에는 한국천문연구원 내에 학회사무실을 설치한다. 이로 인해 연세대와 한국천문연구원 2곳에 사무실을 두게 된다. 이때에 이르러 오규동 회원의 학술상 수상의 맥을 이어 다시 한국우주과학회 학술상 시상을 재개하여 2002년 10월 장헌영과 손영종 회원이 수상했다. 현재는 학술상과 공로

상을 포상위원회에서 선정하고 있다. 이렇게 20주년을 맞이하는 11대에까지 이르게 된다.

어려움 속에서 출발한 한국우주과학회의 역사가 이제 20년을 넘어섰다. 돌이켜보면 창립 시에 가졌던 생각들이 옳았음을 한국 우주과학의 역사가 증명하고 있다. 창립 당시 우주과학을 하는 나라는 미국과 소련을 중심으로 유럽 몇 개 나라와 중국, 일본뿐이었다. 게다가 그때는 국가 간 학문적 교류가 많지 않은 냉전시대라 우주과학에 대한 학문적 바탕이 없는 상황에서 시작해야 했다. 이런 어려움 속에서 출발한 한국 우주과학은 1992년 우리별 1호를 발사해 세계에서 21번째 인공위성 보유국이 된다. 우리별 위성은 2003년 이후 과학기술위성으로 이름을 바꾸고 그 첫 번째로 원자외선 망원경인 FIMS를 비롯하여 과학실험을 위한 많은 탑재체를 우주로 올려놓았다. 이와 더불어 이영욱 박사의 창의적 연구과제인 <자외선 위성 망원경 연구단>을 미국과 공동연구로 결성하고 2003년 3월에 인공위성 갤럭시호를 쏘아 올렸다. 더구나 한국항공우주연구원의 설립으로 이미 7개의 우리 위성이 지구를 돌고 있고, 앞으로 15년 후까지 15개 위성을 더 발사할 계획이다. 과학자의 활동무대를 우주로 확장하고 있는 것이다. 20여 년 전의 꿈과 도전 정신이 있었기에 이와 같은 열매를 맺을 수 있었던 것이다. 후학들이 이보다 더 멋지고, 더 나은 꿈을 가지고 있기에 한국우주과학회의 전망은 밝을 것이다.

몇 시간에 걸친 좌담을 마치면서 자리를 함께 한 분들께 한국우주과학회의 전망에 대한 조언을 부탁했다.

나일성: 한국우주과학회 회원들을 비롯해 우리 학자들이 국내 활동은 매우 활발해졌습니다. 이제는 우주과학회가 더 적극적으로 국제 학계에 진출해주었으면 좋겠습니다. 국제적인 잡지의 게재 동향을 보면 인도, 네델란드 사람들의 것이 많이 줄어들고 근래 들어 일본, 중국 사람들 논문이 늘어나고 있어요. 일본, 중국과 더불어 앞으로 우주과학회가 더 적극적으로 국제 학계에 진출해주었으면 좋겠습니다. 그리고 달과 소행성 등과 같은 행성계에 대한 연구가 부족합니다. 이러한 연구의 결과도 우주과학회지에 게재하는 노력을 기울여주기 바랍니다.

천문석: 한국우주과학회는 우리 원로 선생님들이 열심히 해서 만든 것으로 정말 진통 끝에 만들어진 학회입니다. 요즘 젊은 층에서는 어느 그룹에 속해 있어야하는가 고민하기도 할 텐데, 어딜 가고 안 가고를 떠나서 한국 우주과학의 뿌리가 한국우주과학회라는 것은 알았으면 좋겠습니다. 그 뿌리를 이 땅에 내뻗기 위해 학회를 만들었고, 그렇게 진통이 심하게 만들어진 것입니다. 이 점을 기억했으면 좋겠습니다.

최규홍: 한국우주과학회에 대한 부탁이 있다면 우주과학과 관련된 모든 사람들에게 적극적으로 문호를 개방하는 것은 물론 학회 내에서 중요한 역할을 맡을 수 있는 기회를 주는 열린 학회로 나아가기를 바랍니다. 어려운 가운데서도 정신적으로, 또 물질적으로 도움과 노력을 아끼지 않고 여기까지 올 수 있게 이끌어주신 역대 회장들과 더불어 학회 발전을 위해 함께 노력해주신 회원 여러분들에게 고마움을 전합니다.

한국우주과학회사 20년은 산파 역할을 했던 원로 회원으로부터 현재 활발히 활동하고 있는 젊은 학생에 이르기까지 모든 회원 한 사람 한 사람이 만들어온 역사이며, 지금도 그 역사는 현재진행형으로 쓰여지고 있다. 창립 때의 어려움을 딛고 결국 한국 우주과학의 터전을 일구어 온 것처럼 앞으로도 한국우주과학회는 세계 속의 한국 우주과학의 산실로서 더 풍성하게 꽃 피고 열매를 맺어갈 수 있도록 더 깊이 뿌리 내려갈 것이다.

좌담 장소: 연희동 일식집 <복강>
좌담 일시: 2004년 9월 8일 오전 11시~ 오후 2시

대담자
나일성: 3대 회장, 연세대 천문우주학과 명예교수
최규홍: 7대 회장
천문석: 5대, 8대 회장
진행
강영운: 11대 부회장, 20주년행사준비위원장
김호일: 11대 총무
정리: 송태영 작가

편집자 주: 한국우주과학회의 초대 회장을 역임하시는 등 학회의 발전에 누구 못지않은 커다란 역할을 하신 조경철 초대회장님도 간담회에 모시려고 했으나 사정이 여의치 못해 모실 수 없었습니다. 대신 한국우주과학회 창립 20주년 기념 만찬에서 조경철 초대회장님의 회고담을 들을 수 있는 기회를 마련하였습니다.

공란

공란

등록 교통 숙소 안내

1. 등록

등록비 :

구분	참가유형	등록비		
		등록비합계 (1)	학회지원(2)	본인부담액(3)
개인참석 (4인1실)	A형 (전일참석)	145,000	29,000	116,000
	B형 (27일, 28일)	97,500	19,500	78,000
	C형 (28일, 29일)	62,500	12,500	50,000
독실사용/가족동반	D형 (전일참석)	340,000	29,000	311,000
	E형 (27일, 28일)	195,000	19,500	175,500
	F형 (28일, 29일)	160,000	12,500	147,500

2. 회원 가입

회원가입을 원하시는 분은 등록 장소에 비치되어 있는 입회 원서를 작성하셔서 입회비, 년회비와 함께 제출해 주시기 바랍니다.

※ 입회비: 10,000원, 년회비: 20,000원(학부학생회원은 입회비 없음 년회비: 10,000원)

3. 교통

교통수단	방 법
셔틀버스 (학회제공)	제주공항→해비치 27일 12: 50 해비치→제주공항 29일 14: 00
셔틀버스(해비치제공)	제주공항→해비치 9:50, 11:30, 16:40, 19:50 해비치→제주공항 6:10, 7:20, 10:00, 10:30, 13:00, 15:00. 18:00
버스	제주터미널에서 제주민속촌 가는 버스를 이용한다. 제주민속촌 내려서 약 도보로 5분 거리에 있음
택시	표선콜택시 : 제주공항→ 해비치 15,000원 단 해비치 →제주공항 미터요금 적용 콜택시를 이용하실 분은 출발 전 공항(김포, 청주)에서 미리 예약 후 이용하시면 도착하여 바로 택시를 타실 수 있습니다. 표선콜택시 064-787-2420 일반택시 : 미터요금 적용 약 30,000 ~ 40,000 소요시간 1시간

4. 해비치 리조트 이용 안내

가. 등록장소에서 등록을 마친 후 객실 배정을 받는 후 해비치 프론트에서 키를 받아 체크 인 한다. 27일 체크인 시간은 14:00이며 29일 체크아웃 시간은 12:00입니다. 입 퇴실시간을 지켜 주시고 소지품 분실에 유의하시기 바랍니다.

나. 학회기간 중 불편하신 사항이나 급하게 연락할 사항이 있으시면 학회 사무국장(016-220-3170), 총무이사(011-524-4572), 사무간사(019-574-1211)에게 연락주시기 바랍니다.

다. 전체행사는 에메럴드홀에서 개최되며 구두발표는 그랜드볼룸C, 에메럴드홀, 루비홀에서 각 분과별로 이루어진다(일정표 참조). 포스터발표는 로비와 복도에서 개최되오니 준비한 포스터를 할당된 자리(번호)에 부착시켜 주시기 바랍니다. 포스터 사이즈는 A_0입니다.

라. 식사는 학회에서 배부되는 식권을 사용하시기 바랍니다. 그 외 식사를 이용하는 경우는 개별적으로 하여 주시기 바랍니다.
27일 만찬(저녁): 19:00 - 21:00 에메럴드 홀
28일 중식:12:10 - 13:45 한라산(동양식당)

29일 중식:12:00 - 13:30 한라산(동양식당)

※ 동반되는 가족의 식사비는 별도로 당일 정산하여 주시기 바랍니다.
동반가족 만찬비 1인 25,000원(본인부담액)
중식비 1인 15,000원

마. 29일 학회 종료 후 제주공항까지 2회 셔틀버스가 운행됩니다. 운행시간은 29일 14:00와 18:00 이오니 이용하실 분은 시간에 늦지 않도록 승차하여 주시기 바랍니다.

5. 학회장소 안내

※찾아오시는 길



후 원 기 관

한국천문연구원
Korea Astronomy Observatory

Celebrating 20th Anniversary of
The Korean Space Science Society

International Conference on Astronomy and Space Science

27-29 October 2004

Haevichi Resort, Jeju

The Korean Space Science Society

PROGRAM

Wednesday, 27 October

Session: Astronomy I

Registration & Openning — **H.-I. Kim(KAO)**

14:00 - 15:00 Registration
15:00 - 15:05 National ceremony
15:05 - 15:15 Opening & Welcome ····· Y.-S. Lee (President, KSSS)
15:15 - 15:20 Congratulations ····· S.-H. Cho (President, KAO)

Invited Talk (Emerald Room) — **Chair: Y.-W. Kang(Sejong U)**

15:20 - 15:50 The Evolving Sun and its influence on Planetary Environments
····· Edward Guinan(Villanova U.)

15:50 - 16:00 Break

Astronomy I (Emerald Room) — **Chair: K.-D. Oh(CNNU)**

16:00 - 16:15 Shocked Gas in the Galactic Center Molecular Cloud, Sgr B2
Y. C. Minh(KAO)

16:15 - 16:30 Mass Distribution in the Central Few Parsecs of Our Galaxy
Seungkyung Oh, Sungsoo S. Kim(KHU), Donald F. Figer(STScI), Mark Morris(UCLA)

16:30 - 16:45 FIMS Observations of Hot Interstellar Medium
Kwang-Il Seon(KAO), I.-J. Kim(KAO, KAIST), J.-H. Park(KAO), J.-H.Shinn(KAIST,UC Berkeley), D.-H. Lee(KAO), K.-S.Ryu(KAIST), W. Han(KAO), K.-W. Min(KAIST), H. Jin, I.-S. Yuk, U.-W. Nam(KAO), J. Edelstein, K. Nishikida, E. Korpela, J. Kregenow (UC Berkeley)

16:45 - 17:00 Detection of H2 Fluorescence in Eridanus Region with FIMS
Kwangsun Ryu, Kyoungwook Min(KAIST), Jerry Edelstein(UC Berkeley), Wonyoung Han(KAO), Jongho Shin(KAIST), Daehee Lee, Kwangil Seon, Ukwon Nam, Janghyun Park(KAO), Iljung Kim(KAIST), Eric Korpela(UC Berkeley)

17:00 - 17:15 GALEX Observations for the Look-back Time Evolution of Far-UV Flux from Elliptical Galaxies
Chang H. Ree, Young-Wook Lee, Young-Jong Sohn(Yonsei U), Soo-Chang Rey(CNU), Jaehyon Rhee(Yonsei U), Sukyoung K. Yi, Suk-Jin Yoon (Yonsei U, U of Oxford), Jae-Woo Lee(Sejong U), Sug-Whan Kim(Yonsei U), GALEX Science Team

17:15 - 17:30 Detection of Van Hoof effect in RR Lyrae stars from BOES Observations
Hak-sub Kim, Yong-Ik Byun(Yonsei U)

17:30 - 17:45 Pulsations in Algols current status of researches
David E. Mkrtichian(Sejong U)

17:45 - 19:00 Group Picture, Poster Viewing

19:00 - 21:00 Celebrating Dinner (Emerald Room)

Wednesday, 27 October
Session: Vehicle & Payload

Registration & Openning — **H.-I. Kim (KAO)**

14:00 - 15:00 Registration
15:00 - 15:05 National ceremony
15:05 - 15:15 Opening & Welcome ····· Y.-S. Lee (President, KSSS)
15:15 - 15:20 Congratulations ····· S.-H. Cho (President, KAO)

Invited Talk (Emerald Room) — **Chair: Y.-W. Kang (Sejong U)**

15:20 - 15:50 The Evolving Sun and its influence on Planetary Environments
····· Guinan(Villanova U)

15:50 - 16:00 Break

Vehicle & Payload (Ruby Room) — **Chair: E.-S. Sim (KARI)**

16:00 - 16:15 Flight Software Development for KoDSat
Eun-Jung Choi, Suk-June Park, Jang-Soo Chae, Tae-Sik Oh(KAI)

16:15 - 16:30 Vehicle Dynamics Simulator Development based on the Real-Time
Young-woong Park, Cheol-hea Koo, Bong-kyu Park(KARI)

16:30 - 16:45 Conceptual Design of Small Mass Measuring Device in Micro-gravity
Jong-Woo Kim, Youn-Kyu Kim, Ki-Hyeok Choi, Ju-Hee Lee, Hae-Jin choi(KARI)

16:45 - 17:00 Design of CTE Measuring Device for High-Resolution Telescope Structure
Jong-Min Im, Hong-Bae Kim(KARI)

17:00 - 17:15 Optimized Configurations of Ka-Band Transponder Subsystem for ETRI's SATCOM System
Yong-Min Lee, Seong-Pal Lee, Jae-Woo Park(ETRI)

17:15 - 17:30 Real-Time Orbit Determination Technique using Input Estimation Filter Algorithm for Geo-stationary Satellite
Bang-Yeop Kim, Bong-Kyu Park, and Sang-Cherl Lee(KARI)

17:30 - 17:45 IO Board Design of Next Generation Satellite using the Space Wire Interface
Ki-Ho Kwon, Day-Young Kim, Seung-Woon Choi, Jong-In Lee(KARI)

17:45 - 19:00 Group Picture, Poster Viewing

19:00 - 21:00 Celebrating Dinner (Emerald Room)

Thursday, 28 October
Session: Astronomy II-III

22nd General Assembly (Emerald Room) — **H.-I. Kim (KAO)**

08:30 - 09:00 General Assembly

Invited Talk (Emerald Room) — **Chair: D. Y.Lee (CBNU)**

09:00 - 09:30 How Earth's inner and middle magnetosphere work ····· R. A. Wolf(Rice U)

09:30 - 09:40 Break

Astronomy II (Emerald Room) — **Chair: Y. C. Minh (KAO)**

09:40 - 09:55 Transformation of Extinction Values near the K-Band
Sungsoo S. Kim(KHU)

09:55 - 10:10 Stellar abundance patterns. From quantity to qaulity.
Alexander Yushchenko(Sejong U)

10:10 - 10:25 CREAM: Cosmic Ray Balloon Mission in Antarctica
J.Yang, H.J.Hyun, I.H.Park, J.A.Jeon, J.H.Han, J.K.Lee, M.Y.Kim, N.H.Park, S.J.Baek, S.W.Nam(EWU), H.B.Park, H.J.Kim, Y.J.Kim(KPU), K.W.Min(KAIST), K.I.Seon, W.Han,W.Nam(KAO), H.S.Ahn, O.Ganel, M.H.Lee, L.Lutz, A.Malinine, E.S.Seo, S.Y.Zinn(U of Maryland)

10:25 - 10:40 Optimal Deflection of Earth-Crossing Asteroids Using Laser Energy
Byeong-Hee Mihn, Sang-Young Park, and Kyu-Hong Choi(Yonsei U)

10:40 - 10:55 Grinding Optimization Model for Nanometric Surface Roughness for Aspheric Astronomical Optical Surfaces
Jeong-Yeol Han(KAO, UST), Sug-Whan Kim(Yonsei U), Geon-Hee Kim, In-Woo Han(KAO),Ju-Whan Kim(KBSI)

10:55 - 11:10 Coffee Break, Poster Viewing

Astronomy III (Emerald Room) — **Chair: W. Han (KAO)**

11:10 - 11:25 A Method for Testing Surface Deforms of Large Convex Mirrors
Young-Soo KIM(KAO)

11:25 - 11:40 Fabrication of Nb/Al Superconducting Tunnel Junction as a Novel Astronomical Detector
Jang-Hyun Park, Young-Sik Park(KAO), Sung-Ik Cho(KAO, Yonsei U), Yong-Ho Lee, Sang-Kil Lee(KRISS), Sug-Whan Kim(Yonsei U), Wonyong Han(KAO)

11:40 - 11:55 Development Study of Local Oscillator System for mm-wave Radio Receiver
C.H. Lee, S.T. Han, K.D. Kim, M.H. Chung, H.R. Kim(KAO)

11:55 - 12:10 Design of KAO Near Infrared Camera System on the SOAO 0.6m Telescope
Ho Jin, Soojong Park, In-Soo Yuk, Sungho Lee(KAO), Bongkon Moon(KAO, CNU), Jeong-Yeol Han(KAO, UST), Kwag-Il Seon, Jina Kang(KAO), Kyung-Nam Kong(KAO, CNU), Wook-Won Nam, Dae-Hee Lee(KAO)

12:10 - 13:45 Lunch Break

13:45 - 18:00 Poster Viewing

Thursday, 28 October

Session: Satellite Orbit I-II

22nd General Assembly (Emerald Room) — **H.-I. Kim (KAO)**

08:30 - 09:00 General Assembly

Invited Talk (Emerald Room) — **Chair: D.-Y. Lee (CBNU)**

09:00 - 09:30 How Earth's inner and middle magnetosphere work ····· R. A. Wolf(Rice U)

09:30 - 09:40 Break

Satellite Orbit I Grand Ball Room — **Chair: B.-S. Lee (ETRI)**

09:40 - 09:55 Orbit Propagation Software for Mars Orbiting Spacecraft
Young-Joo Song, Sung-Moon Yoo, Eun-Seo Park, Sang-Young Park, Kyu- Hong Choi(Yonsei U), Jae-Cheol Yoon, Joon-Min Choi, Han-Dol Kim, Byung-Kyo Kim(KARI)

09:55 - 10:10 DSN Measurement Model Development for Interplanetary Navigation
Hae-Yeon Kim, Eun-Seo Park, Young-Joo Song, Kyung-Min Rho, Sung-Moon Yoo, Sang-Young Park, Kyu-Hong Choi(Yonsei U), Jae-Cheol Yoon, Jo-Ryung Yim, Jun-Min Choi, Byung-Kyo Kim(KARI)

10:10 - 10:25 Dynamic Model Development For Interplanetary Navigation
Eun-Seo Park, Sung-Moon Yoo, Young-Joo Song, Sang-Young Park, Kyu-Hong Choi(Yonsei U), Jae Cheol Yoon, Jo Ryeong Yim, Byung Kyo Kim, Joon-Min Choi, Seung-Woo Rhee(KARI)

10:25 - 10:40 Optimal Trajectory Design For Human Outer Planet Exploration
Sang-Young Park(Yonsei U), Hans Seywald, Shawn A. Krizan(AMA Inc), Frederic H. Stillwagen(NASA Langley Research Center)

10:40 - 10:55 Development of Precision Attitude Determination System for KOMPSAT-2
Jae-Cheol Yoon(KARI), Dongseok Shin, Hungu Lee, Young-Ran Lee(Satrec I), Hyunjae Lee, Hyo-Choong Bang(KAIST), Yee-Jin Cheon, Jae-Min Shin, Hong-Youl Moon, Sang-Ryool Lee, Gab-Ho Jeun(KARI)

10:55 - 11:10 Coffee Break, Poster Viewing

Satellite Orbit II Grand Ball Room — **Chair: S.-Y. Park (Yonsei U)**

11:10 - 11:25 Developnent of the KOMPSAT-2 Satellite Mission Control System
Byoung-Sun Lee, Sanguk Lee, Hee-Sook Mo, Sungki Cho, Won Chan Jung, Myungja Kim, In-Jun Kim, Tae-Hee Kim, Inone Joo, Yoola Hwang, Jaehoon Kim(ETRI)

11:25 - 11:40 A study on Initial conditions for Satellite Formation Flying using State Transition Matrix
Hyo-Joon Bang, Sang-Young Park and Kyu-Hong Choi(Yonsei U)

11:40 - 11:55 Development of Sun-Glint Prediction Program For The Communication, Ocean and Meteorological Satellite
Jae-Ik Park, Kyu-Hong Choi, Sang-Young Park(Yonsei U), Yu-Hwan Ahn(KORDI)

11:55 - 12:10 Estimation of Solar Radiation Pressure on the Geostationary Satellite with a Single Solar Array Configuration
Gwanghyeok Ju, Youngwoong Park, Bang-Yeop Kim, Bong Kyu Park(KARI)

12:10 - 13:45 Lunch Break

13:45 - 18:00 Poster Viewing

Thursday, 28 October
Workshop on Space Science

22nd General Assembly (Emerald Room) — **H.-I. Kim(KAO)**

08:30 - 09:00 General Assembly

Invited Talk (Emerald Room) — **Chair: D.-Y. Lee (CBNU)**

09:00 - 09:30 How Earth's inner and middle magnetosphere work ····· R. A. Wolf(Rice U)

09:30 - 09:40 Break

Space Science I (Ruby Room) — **Chair: B.-H. Ahn (KPNU)**

09:40 - 10:10 Compelling Evidence Supporting the Boundary Layer Dynamics Model of Substorms
Gordon Rostoker(U of Alberta)

10:10 - 10:40 Large-Scale Geomagnetic Disturbances Driven by Solar-Wind Discontinuities
L. R. Lyons(UCLA), D.-Y. Lee(CBNU)

10:40 - 11:00 Characteristics of geosynchronous particle flux disturbances caused by the solar wind dynamic pressure enhancement
D.-Y. Lee(CBNU), L. R. Lyons(UCLA)

11:00 - 11:20 Coffee Break, Poster Viewing

11:20 - 11:40 KAO Space Weather Monitoring System: I. Overview
Kyung-Seok Cho, Yong-Jae Moon, So-Young Park, Hyungmin Park(KAO), Young-Deuk Park(KAO, NJIT) Yeon-Han Kim(KAO), Roksoon Kim(KAO, CNU), Jung-Eun Hwangbo(KAO, CBNU)

11:40 - 12:00 Development of the Technology to locate and to observe Solar Bursts
Yong-Jae Moon, Kyung-Seok Cho, Young-Deuk Park, Yeon-Han Kim, Jung-Eun Hwangbo, Su-Chan Bong(KAO)

12:00 - 12:20 Interaction of the Magnetic Cloud and the Interplanetary Shock with Cosmic Rays
Su-Yeon Oh, Yu Yi(CNU)

12:20 - 14:00 Lunch Break

Space Science II (Ruby Room) — **Chair: D.-H. Lee (KHU)**

14:00 - 14:30 Space Weather Studies at Kyushu University
Kiyohumi Yumoto(Kyushu U)

14:30 - 15:00 Spacecraft observations of ULF waves
Kazue Takahashi(Johns Hopkins U)

15:00 - 15:30 The Plasmasphere, and a Model for Plasmaspheric Density on 29 August 2000
Richard E. Denton(Dartmouth College, USA), Jerry Goldstein(Southwest Research Institute,USA)

15:30 - 16:00 Coffee Break, Poster Viewing

Space Science Ⅲ (Ruby Room) — Chair: D.-Y. Lee (CBNU)

16:00 - 16:20 Plasma Wave Coupling in Inhomogeneous Space: A New Approach
Dong-Hun Lee, Eun-Hwa Kim, Kyung-Sub Kim(KHU), Kihong Kim(Ajou U)

16:20 - 16:50 The Predictability of the Magnetosphere and Space Weather
Xinlin Li(U of Colorado at Boulder)

16:50 - 17:10 Study on the Geosynchronous Relativistic Electron Events
Hee-Jeong Kim, Dae-Young Lee(CBNU)

17:10 - 17:30 A case study to determine the relationship of relativistic electron events to substorm injections and ULF powers
Junga Hwang, Kyoung Wook Min(KAIST), Ensang Lee(UC Berkeley), China Lee(KAIST), Dae Young Lee(CBNU)

Friday, 29 October
Session: Satellite Orbit Ⅲ-Ⅳ

Invited Talk (Emerald Room) — **Chair: P.-H. Park(KAO)**

08:30 - 09:00 IGS: Services for Science and General Public ·····Peng Fang(UC San Diego)

09:00 - 09:10 Break

Satellite Orbit Ⅲ (Emerald Room) — **Chair: J.-W. Park(KAO)**

09:10 - 09:25 Operational Orbit Determination Using GPS Navigation Data
Yoola Hwang, Byoung-Sun Lee, Jae-Hoon Kim(ETRI)

09:25 - 9:40 GPS based prediction of the Instantaneous Impact Point for KSLV-I
Sang-Wook Kang, Sang-Young Park, and Kyu-Hong Choi(Yonsei U)

09:40 - 09:55 LEO Satellite orbit maneuvers for increasing resolution of space image
Hyung-Mo Oh, Sang-Young Park, Kyu-Hong Choi(Yonsei U)

09:55 - 10:10 Covariance Analysis of Two Spacecraft System Using Relative Line of Sight Vector Measurements
Jo Ryeong Yim, Yong-Bok Kim, Seung-Wu Rhee(KARI)

10:10 - 10:25 Formation Trajectory-Planning using Nonlinear Programming and Collocation
Hyung-chul Lim(KAO, KAIST), Hyochoong Bang(KAIST),
Pil-ho Park, Jong-uk Park(KAO)

10:25 - 10:40 Determination of Tropospheric Slant Wet Delay Using GPS
Jihyun Ha(KAO, CBNU), Kwan-Dong Park(KMU), Pil-Ho Park, Jong-Uk Park(KAO)

10:40 - 10:55 Coffee Break, Poster Viewing

Satellite Orbit Ⅳ(Emerald Room) — **Chair: P.-H. Park(KAO)**

10:55 - 11:10 Station-Keeping Maneuver Simulation for the communication Ocean and Meteorological Satellite
Young-Rok Kim(Yonsei U), Byoung-Sun Lee(ETRI), Hyo-Joon Bang,
Kyu-Hong Choi, Sang-Young Park(Yonsei U)

11:10 - 11:25 A Reduced Dimensional Gimbal Rate Steering Law for Singularity-Free Control
Bong-Un Lee, Do-Hyeon Kim, So-Jung Kim, Hwa-Suk Oh(KAU)

11:25 - 11:40 Dynamic Compensation in Measurments and Identification of Reaction Wheel Disturbance Model
Hwa-Suk Oh, Dong-Ik Cheon, Shin-Hoo Choi(KAU)

11:40 - 11:50 Break

Closing

11:50 - 11:55 Announcement ····· H.-I. Kim(KAO)
11:55 - 12:00 Closing Remark ····· Y.-S. Lee, President

12:00 - 13:30 Lunch

Friday, 29 October

Session: Satellite Management I-II

Invited Talk (Emerald Room) — **Chair: P.-H. Park(KAO)**

08:30 - 09:00 IGS: Services for Science and General Public ·····Peng Fang(UC San Diego)

09:00 - 09:10 Break

Satellite Management I (Ruby Room) — **Chair: S. Cho (KAO)**

09:10 - 09:25 Design and Implementation of On-Board Computers For STSAT-2
Changwan Ryu, Myungjin Choi, Daesoo Oh, Kyungin Kang, Myeong-Ryong Nam(KAIST), Junghoon Keum(KARI)

09:25 - 9:40 Calibration and Error Analysis of Performance Test Equipments for Sun Sensor
Shi-HWan Oh, Yong-Bok Kim, Seung-Hoon Lee, Jo Ryeong Yim, Hong-Taek Choi and Seung-Wu Rhee(KARI)

09:40 - 09:55 Research of Proton Irradiation Effect by Ground Based MC-50 Cyclotron for Spacecraft's Shielding of Polyimide Kapton
Dae-Weon Kim(SNU), Dong-Iel Kim, Yong-Hak Huh(KRISS), Tae-Keun Yang(KIRMS), Yong-Hyup Kim(SNU)

09:55 - 10:10 Development of A Photogrammetry System for Use under Thermal Vacuum Environment
Sang-Hoon Lee, Hyokjin Cho, Hee-Jun Seo,Chang-Wuk Woo, Guee-Won Moon and Seok-Weon Choi(KARI)

10:10 - 10:25 Thermal System Design for a Large Space Simulator (Φ8mXL10m)
Guee-Won Moon, Chang-Lae Cho, Hyokjin Cho, Sang-Hoon Lee, Hee-Jun Seo, Seok-Weon Choi(KARI)

10:25 - 10:40 Evaluation of the Measurement Noise and the Systematic Errors for the KOMPSAT-1 GPS Navigation Solutions
Hae-Dong Kim, Eun-Kyou Kim, Hae-Jin Choi(KARI)

10:40 - 10:55 Coffee Break, Poster Viewing

10:55 - 11:10 Korea Astronaut Mission Proposal with Analyzing Astronaut Missions of European Space Agency
Youn Kyu Kim, Jong-Woo Kim, Joo-Hee Lee , Gi-Hyuk Choi(KARI)

11:10 - 11:25 The Selection Criteria of Korean Astronauts
Joo-Hee Lee, Gi-Hyuk Choi, Youn-Kyu Kim, Jong-Woo Kim(KARI), Won-Kuen Lee(Hanseo U),Sang-Ho Hwang(Air Force)

11:40 - 11:50 Break

Closing

11:50 - 11:55 Announcement ····· H.-I. Kim(KAO)

11:55 - 12:00 Closing Remark ····· Y.-S. Lee, President

12:00 - 13:30 Lunch

Poster Session I

27 October 15:00 ~ 28 October 12:00

Astronomy

(P1- 1) Eclipsing Binaries, The primary Distance Indicator
Young Woon Kang, Kyeong-Soo Hong(Sejong U), Ho-il Kim, Woo-Baik Lee(KAO)

(P1- 2) Star Formation in the Large Magellanic Cloud
Sungeun Kim(Sejong U)

(P1- 3) CCD Photometry Using Multiple Comparison Stars
Distance and accreton luminosity of the long-period eclipsing polar V1309Ori
Yonggi Kim(CBNU), Ivan L. Andronov(Odessa National U, CBNU),
Young-Beom Jeon(KAO)

(P1- 4) Simulations of the photospheric convection in subgiant stars
Y. -C.Kim(Yonsei U), F. J. Robinson(Yale U), K. L. Chan(HKUST), P. Demarque(Yale U)

(P1- 5) FIMS Observations of The Monogem Ring
Il-Joong Kim(KAIST, KAO), K.-I. Seon(KAO), K.-W. Min, K.-S. Ryu(KAIST),
D.-H. Lee, W. Han, W.-W. Nam, I.-S. Yuk, J.-H. Park(KAO),
H. Jin, J. Edelstein, E. Korpela, K. Nishikida(UC Berkeley)

(P1- 6) Absolute Parameters of a eclipsing binary AG Virginis
Ho-Il Kim, Chung-wook Lee, Jae-Woo Lee(KAO)

(P1- 7) The effects of α-element enhancement on isochrones; A detailed analysis
Song Eui Park, Yong -Cheol Kim(Yonsei U)

(P1- 8) CO to H2 ratio of interstellar molecular cloud
Jae-Woo Park(KAIST), Dae-hee Lee(KAO), Kyoung-Wook Min(KAIST)

(P1- 9) Low Mass Ratio Contact Binary V410 Aur and V776 Cas
Kyu-Dong Oh(Chonnam National U), Chun-Hwey Kim(CBNU) Ho-Il Kim, Woo-Baik Lee(KAO)

(P1-10) Chemical Enrichment and Star Formation Histories of the Sextans Dwarf Spheroidal Galaxy
In-Soo Yuk(KAO), Myung Goon Lee(SNU)

(P1-11) Observation of molecular hydrogen fluorescence in the Taurus region by FIMS
Dae-Hee Lee, Ho Jin, Uk-Won Nam, Wonyong Han(KAO), Kwang-Sun Ryu, Jong-Ho Shinn,
Kyoung-Wook Min(KAIST), Jerry Edelstein, Kaori Nishikida, Eric Korpela(UCB)

(P1-12) A new pre-data reduction program for the array On-The-Fly observations
Myung-Hyun Rhee(Yonsei U), Hyoryoung Kim(TRAO), Eun-Jung Jung(Yonsei U)

(P1-13) Dynamical Substructures of Galactic Globular Clusters
Jongwhan Rhee and Young-Jong Sohn(Yonsei U)

(P1-14) The spectral analysis of the dayglow limb scanning data of FIMS in STSAT1
Chi-Na Lee, Kyung-Wook Min(KAIST), Kyang-Sun Ryu(SaTReC)

(P1-15) The Radial Velocity Study of the Near Contact Binary BX Andromedae
Chung-Uk Lee, In-Woo Han, Kang-Min Kim(KAO), Chun-Hwey Kim(CBNU)

Poster Session I

27 October 15:00 ~ 28 October 12:00

(P1-16) The present status and research activities of the International Virtual Observatory Alliance
In Sung Yim, Hyun Il Sung, Sang Chul Kim, Sangmo Tony Sohn, Young Sook Ahn, Bong Gyu Kim(KAO)

(P1-17) Hydrodynamic Simulations of the 200-pc Molecular Ring
Myoung Won Jeon, Sungsoo S. Kim(KHU)

(P1-18) BOES Spectroscopic Study of the Accretion Flow in the Symbiotic Star V1016 Cyg
Yangy-Chan Jung, Hee-Won Lee(Sejong U), Sook-Hyang Yi(KNUE), Sang-Hyeon Ahn(KAO)

(P1-19) Light Element And Ni Abundance In Field Metal-Poor Stars
Hyun-jin Jeong(Yonsei U), Jae-Woo Lee(Sejong U), Sug-Whan Kim, A-Ram Kang(Yonsei U)

(P1-20) Surface Brightness Fluctuations in GALEX UV Passbands as Population Indicators
Hye Jeon Cho,Young-Wook Lee(Yonsei U)

(P1-21) Eclipsing Binaries in the Central Bar of the Large Magellanic Cloud
Kyeong-Soo Hong(Sejong U), Choong-Uk Lee, Chun-Hwey Kim(CBNU), Kyu-Dong Oh(CNU), Young Woon Kang((Sejong U)

(P1-22) Accurate Absolute Dimensions and Distances of 10 Eclipsing Binaries
Kyeong-Soo Hong, Changdeok Hwang, Seunghwa Kook, Yang-Chan Jung, Jungho Kim, Young Woon Kang(Sejong U)

(P1-23) First Multi-color Light Curves of V473 Cas
Changdeok Hwang(Sejong U), Tae-yeon Jeong(Sejong U PGHS), Young-Soo Kim(KAO), Young Woon Kang(Sejong U)

(P1-24) Acoustic p-mode spacing and splitting in enigmatic rapidly-oscillating chemically peculiar magnetic star HD101065 (Przybylski's star)
David E. Mkrtichian(Sejong U), Artie P.Hatzes(Tautenburg)

(P1-25) Distance and accreton luminosity of the long-period eclipsing polar V1309Ori
Klaus Reinsch(Goettingen U), Yonggi Kim(CBNU), Klaus Beuermann(Goettingen U)

(P1-26) Chemical Abundances for Seven Giant Stars In M68 (NGC 4590)
Jae-Woo Lee(Sejong U)

History of Astronomy

(P1-27) The Solar Eclipse Predictions of Chiljeongsan-Oepyeon in Choseon Dyn.
Young Sook Ahn(KAO), Yong Sam Lee(CBNU)

(P1-28) The research of five planets diagrams in the Jegdo-nambuk-chongseongdo (=赤道南北總星圖)
Gil Sun Oh(Kangwondo, Korea), Young Sook Ahn(KAO)

(P1-29) Accuracy of Gnomonic Measurements in Korea and China
Eun-Hee Lee(Yonsei U), Kwan-Yu Chen(U of Florida)

(P1-30) Astronomical Observation as a practical experience learning program
Dong-Joo Han, Yonggi Kim(CBU)

Astronomical Instruments

(P1-31) OECD Global Science Forum Near Earth Object International Steering Committee Progress Report
Hong-Kyu Moon, Wonyong Han, Hong-Suh Yim(KAO), Yong-Ik Byun(Yonsei U)

Poster Session I

27 October 15:00 ~ 28 October 12:00

(P1-32) A study of mechanical design and thermal analysis of KAONICS (KAO Near-Infrared Camera System)
Bongkon Moon(KAO, CNU), Jina Kang, Sungho Lee, In-Soo Yuk1, Ho Jin, Kwang-Il Seon, Soojong Pak(KAO)

(P1-33) Optical Alignment of KAO Wide Field Telescope (NEOPAT)
In-Soo Yuk, Jae-Mann Kyeong, Joh-Na Yoon, Jae-Hyuck Yoon, Hong-Suh Yim, Hong-Kyu Moon, Wonyong HanKAO)

(P1-34) Automatic observaton and control system with MEADE LX 200
Joh-Na, Yoon(CBNU, KAO), Chung-Uk Lee(KAO), Sang-Mok Cha,Yonggi Kim(CBNU)

(P1-35) Optics Design of the KAO Near Infrared Camera System (KAONICS)
Sungho Lee, In-Soo Yuk(KAO), Jeong-Yeol Han(KAO,UST), Bongkon Moon(KAO, CNU), Soojong Pak, Ho Jin(KAO), Jeong-Gi Lee, Cheon-Seog Rim(Hannam U)

Space Science

(P1-36) CME geoeffectiveness according to its orientation and chirality
Seung-Mi Kang(KPU, KAO), Young-Jae Moon, G. S. Choe(KAO)

(P1-37) High-latitude Thermospheric Winds and Momentum Forcing: Dependence on the Interplanetary Magnetic Field
Young-Sil Kwak, Byung-Ho Ahn(KPU), Arthur D. Richmond(NCAR)

(P1-38) Conversion of Ordinary Waves into Upper Hybrid Waves in Inhomogeneous Plasmas
Kyung-Sub Kim, Eun-Hwa Kim, Dong-Hun Lee(KHU)

(P1-39) Propagation of Nonlinear Magnetosonic Waves
Kyung-Im Kim, Sungsoo S. Kim, Dong-Hun Lee(KHU), Kihong Kim(Ajou U)

(P1-40) Solar Wind Dynamic Pressure during Magnetic Storms and Its Implications on the Dayside Ring Current Particle Loss
Kyungchan Kim, D.-Y. Lee(CBNU), Ensang Lee(CA, USA)

(P1-41) The effect of slow recombination of H3+on the Jovian ionosphere
Yong Ha Kim(CNU), Tae Seog Yoon(KPU)

(P1-42) Effects of heavy ions on ULF waves in the magnetosphere
Eun-Hwa Kim, Dong-Hun Lee(KHU)

(P1-43) The correlation between solar EUV flux and plasma characteristics in the low-latitude topside ionosphere at nighttime
Heejun Kim, Jaeheung Park, Kyoung W. Min(KAIST)

(p1-44) KAO space weather monitoring system: II. Real-time data acquisition tools and applications
Hyungmin Park, Yong-Jae Moon, Kyung-Seok Cho, So-Young Park, Woo-Kyoung Lee, Young-Deuk Park and Yeon-Han KimKAO)

(P1-45) KAO Space Weather Monitoring System: III. Nowcast, Forecast and Database
So-Young Park, Kyung-Seok Cho, Yong-Jae Moon, Hyungmin Park(KAO), Roksoon Kim(KAO, CNU), Jung-Eun Hwangbo(KAO, CBNU), Young-Deuk Park(KAO, NJIT, USA), Yeon-Han Kim(KAO)

Poster Session I

27 October 15:00 ~ 28 October 12:00

(P1-46) Equatorial Plasma Bubbles in the Premidnight Sector During Solar Maximum as Observed by KOMPSAT-1
Jaeheung Park, Kyoung-Wook Min(KAIST, Vitaly P. Kim(IZMIRAN, Moscow Region, Russia), Hee-Jun Kim(KAIST)

(P1-47) The ionospheric variation of radio waves on the Korea Peninsula
Sung-Bok Baek, Dong-Hun Lee(KHU), Yoo-Surn PyoA(RRL)

(P1-48) A statistical study of solar wind dynamic pressure enhancements during geomagnetic storms
Ji-Hye Baek, Dae-Young Lee(CBNU)

(P1-49) The effect of dust particles on ion acoustic solitary waves in a dusty plasma
Cheong Rim Choi, Dae-Young Lee, Younggi Kim(CBNU)

Satellite

(P1-50) Angles Only Orbit Determination From Single Tracking Station
Byoung-Sun Lee and Yoola Hwang(ETRI)

(P1-51) Launch Stage Thermal Analysis for Satellite Box Under Two Extreme Thermal Conditions By Using Analytical Approach
Hui-Kyung Kim, Joon-Min Choi, Bum-Seok Hyun, Jang-Joon Lee, and Hak-Jung Kim(KARI)

(P1-52) Service & Network Operation of The Multibeam Switching Satellite Communications System
Kyung Soo Choi, Cheon Sig Sin, Jin Ho Jo, Yong Min Lee and Seong Pal Lee(ETRI)

Vehicle

(P1-53 Development of Performance Simulation Software for Satellite Reaction Control Thruster
Cho Young Han, Moon Gyung Nam, Eung Sik Park(KARI)

Poster Session II

28 October 12:00 ~ 29 October 12:00

Vehicle

(P2- 1) Basic Design Analysis of Rocket Test Facility for KSLV Propulsion Unit
Sun-Il Kang, Jung-Ho Lee, Yong-Wook Kim, Seung-Hyub Oh(KARI)

(P2- 2) The Cryogenic Regulator Design for Liquid Propulsion System
Gyoung-sub Kil, Joong-Youp Lee, Han-Bee Na, Byung-Hun Kim, Young-Gab Chung(KARI)

(P2- 3) A Conceptual Design for Electrical Grounding Architecture of Korean Space Launch Vehicle
Kwang-Soo Kim, Soo-Jin Lee, Keun-Soo Ma, Myoung-Ho Shin, Seung-Hyun Hwang, Ki-Man Ji, Eui-Seung Chung(KARI)

(P2- 4) Development of Tracking Systems Applicable To Space Launch Vehicle
Sung-Wan Kim, Soo-Seul Hwang and Jae-Deuk Lee(KARI)

(P2- 5) A Study on the Prediction of the Base Flow Characteristics of a Launch Vehicle Using CFD
Younghoon Kim, Honam Ok, Insun Kim(KARI)

(P2- 6) A Study on Degreasing Detergent and Method for the IPP test facility
Yong-Wook Kim, Jung-Ho Lee, Sun-Il Kang(KARI), Sang-Heon Kim(ROTEM), Seung-Hyub Oh(KARI)

(P2- 7) An Investigation on the Performance of a Propulsion System with the Branch Location of an Oxidizer Feeding Line
Ji Hoon Kim, Han Ju Lee, Dong Ho Jung, Yong Wook Kim and Seung Hyub Oh(KARI)

(P2-08) Anaysis of Engine Starting Mode with a Pyro-Starter
Moon, Insang, Park, Soon-Young and Choi, Hwan-seok Choi(KARI)

(P2-09) Residual Propellant Gauging Method Using Thermal Pumping of Multi-tanks Satellite System
Park Eung Sik , Moon Gyung Nam(KARI)

(P2-10) Explicit Guidance Thrust Integrals Derivation for a Launch Vehicle With Varying Thrust
Eun-Jung Song, Woong-Rae Roh(KARI)

(P2-11) Design and Functional test of On-board Flight Analog Video System
Sang-Rae Lee, Sung-Wan Kim, Jae-Deuk Lee(KARI)

(P2-12) An Analytical Study on the Dynamic Characteristics of a Liquid Propulsion System
Han Ju Lee, Seok Hee Lim, Dong Ho Jung, Yong Wook Kim, and Seung Hyub Oh(KARI)

(P2-13) Shock Wave Boundary Layer Interaction Studies In Corner Flows
Hee-Joon Lee(KARI), Jan B. Vos(Ecole Polytechnique Federale de Lausanne)

(P2-14) An analysis of thrust and specific impulse of the Liquid Rocket Engine according to the change of chamber pressure and the flight height
Seok-Hee Lim, Young-Suk Jung, Kie-Joo Cho, Gyu-Sik Cho, Seung-Hyub Oh(KARI)

Poster Session II

28 October 12:00 ~ 29 October 12:00

(P2-15) The Variation of System by Density-Drop of Propellants in LRE
Young-Suk Jung, Kie-Joo Cho, Gyu-Sik Cho, Seok-Hee Lim, Seung-Hyub Oh(KARI)

(P2-16) The dynamic analysis of a thruster system in a Satellite launch vehicle
Taekyu Jung, Joongyup Lee, Sangyup Han, Youngmok Kim(KARI)

(P2-17) Tank Depletion System for Space Launch Vehicle
Kie-Joo Cho, Young-Suk Jung, Gyu-Sik Cho and Seung-Huyb Oh(KARI)

(P2-18) Introduction of the Program Life-cycle Management System for Space Launch Vehicle Development
Miok Joh, Young-In Choi, Kyoun-Su Seo, Bum-Seok Oh, Gwang-Rae Cho(KARI)

(P2-19) Reliability Demonstration of Propulsion System of Space Launch Vehicle
Yong-Wook Kim, Sang-Yeon Cho, Seung Hyub Oh, Chan-Bin Park(KARI)

(P2-20) Ascent Thermal Analysis of Fairing of Space Launch Vehicle
Sang-Ho Choi, Seong-Lyong Kim, Insun Kim(KARI)

(P2-21) Prelaunch Thermal Analysis of KSLV-I Payload Fairing
Sang-Ho Choi, Seong-Lyong Kim, Insun Kim(KARI)

(P2-22) Development of Thermal Control System for Cryogenic Environment of Launch Vehicle
SangYeop Han, Seong-Up Ha, Byung-Hoon Kim, Young-Mog Kim(KARI)

Satellite

(P2-23) Current Status of STSAT1 Satellite by on-Orbit Log Information
Kyung-In Kang, Geun-Soo Shin, Hong-Young Park, Kyung-Hee Kim, Jong-Joo Lee, Sae-Il Kim, Jong-Tae Lim(KAIST)

(P2-24) The Implementation Method and Test of Telemetry Trend Analysis in KOMPSAT-2
Myungja Kim, Won-Chan Jung, Jae-Hoon Kim(ETRI)

(P2-25) Error Analysis of SEE qualification for C860 Microprocessor
Sung-Joon Kim(KAIST), Jongho Seon(SaTReC*i*), Kyoung-Wook Min, Wonho Choe, Dai-ho Ko(KAIST)

(P2-26) A Proposed High Availability Architecture for Coms Ground Control System
In-Jun Kim, Jae-Hoon Kim(ETRI)

(P2-27) Efficient Thermal Modeling In Development of a Spaceborne Electronic Equipment
Jung-Hoon Kim, Ja-Chun Koo(KARI)

(P2-28) Design and Implementation of Telemetry Interface for KSLV-I
Joonyun Kim(KARI), Bo-Gwan Kim(CNU)

(P2-29) K-2 Bus Platform Evaluation Based on The Analysis of RF System Characteristics
Tae-Youn Kim, Byung-Hee Min, Seong-Bin Lim and Seok-Won Choi(KARI)

Poster Session II

28 October 12:00 ~ 29 October 12:00

(P2-30) Bus System Evaluation by Conduction Noise Injection
Tae-Youn Kim, Seong-Bin Lim and Seok-Won Choi(KARI)

(P2-31) Calibration of Image Geolocation by Thermal Distortion Map
Hee-Sub Kim, Eyunhyun Kim, Bum-Seok Hyun(KARI)

(P2-32) The Conceptual Design of a Power Control and Distribution Unit for the Next Generation Satellite
Sung-Woo Park, Jin-Baek Jang,Hee-Sung Park, Sung-Soo Jang, and Jong-In Lee(KARI)

(P2-33) Design of a Scalable Power Bus Regulator for PCDU of Satellites
Sung-Woo Park(KARI), Jong-Duck Kim(KAI),
Hee-Sung Park, Jin-Baek Jang, Sung-Soo Jang(KARI)

(P2-34) The MPPT Design for Small Satellite in LEO
Hee-Sung Park, Sung-Soo Jang, Sung-Woo Park, Jin-Beak Jang and Jong-In Lee(KARI)

(P2-35) Unit Modeling For Conducted Emission Noise Analysis of a Satellite System
Yong-Sik Chun, Na-Young Lee, Jin-Ho Lee, Sang-Ryool Lee and Joo-Jin Lee(KARI)

(P2-36) The Analysis on Space Radiation Environment of STSAT-2
Seung-Hun Lee and Eun-Sup Sim(KARI)

(P2-37) A Comparison of Thermal Math Modelings for Power Cable in Space Environment Simulation
Jang-Joon Lee, Hui-Kyung Kim, Bum-Seok Hyun and Joon-Min Choi(KARI)

(P2-38 Ka-band Antenna Performance Analysis of COMS Satellite
Jeom-Hun Lee, Jang-Sup Choi, Seong Pal Lee(ETRI)

(P2-39) A Position Tracking Algorithm with Radar Measurement
You-Chol Lim, Keun-Soo Ma, Jae-Deuk Lee(KARI)

(P2-40) Satellite Operation Plan at Launch Site for Launch Preparation
eong-Heum Im, Sang-Kon Lee, Sang-Ryool Lee(KARI)

(P2-41) Front End Telemetry Data Acquisition Unit for KSLV-I Upper Stage
Hae-Seung Jung, Joonyun Kim, Jae-Deuk Lee(KARI)

(P2-42) KOMPSAT-2 RF Compatibility Test for S-Band
Seung-Won Cho, Young-Su Youn, Jong-Yeon Choi, Seok-Weon Choi(KARI)

(P2-43) A Study on Thermally Induced Dynamics of the Geostationary Satellite with a Single Solar Array
Gwanghyeok Ju, Hyoung Yoll Jun, Koon-Ho Yang(KARI)

(P2-44) A Comparison Study of Space Radiation Dose Analysis Programs:
SPENVIS Sectoring Tool and SIGMA II
Jongwon Chae(KARI)

(P2-45) Design of Common EGSE & EGOE System for Satellite Test & Mission Control Element
Yong-Sik Chun, Sang-Kon Lee(KARI), Sung-Woong Ra(KNU)

Poster Session II

28 October 12:00 ~ 29 October 12:00

(P2-46) Environmental Test of the EQM Payload System for the Communications and Broadcasting Satellite
Jang Sup Choi,Jong Heung Park,Jong Won Eun, Seong Pal Lee(ETRI)

(P2-46) Environmental Test of the EQM Payload System for the Communications and Broadcasting Satellite
Jang Sup Choi,Jong Heung Park,Jong Won Eun, Seong Pal Lee(ETRI)

(P2-47) The Design of System Software - EXEcutive CSC for KOMPSAT-2
Jong-Wook Choi, Jae-Seung Lee(KARI)

(P2-48) Comparison of Numerical Prediction with Test Results at Space Thermal Simulation Test
Hui-Kyung Kim, Bum-Seok Hyun, Jang-Joon Lee, and Joon-Min Choi(KARI)

(P2-49) Thermal Design on Satellite Payload Fixture for Space Simulation Ground Test
Jang-Joon Lee,Bum-Seok Hyun, Hui-Kyung Kim, and Joon-Min Choi(KARI)

(P2-50) Thermal Analysis for Space Simulation Test Preparation
Jang-Joon Lee, Hui-Kyung Kim, Bum-Seok Hyun and Joon-Min Choi(KARI)

(P2-51) Vertical Ozone Density Profiling by UV Radiometer onboard KSR-III
Seung-Hyun Hwang(KARI), Jhoon Kim(Yonsei U), Soo-Jin Lee, Kwang-Soo Kim, Ki-Man Ji, Myung-Ho Shin, Eui-Seung Chung(KARI)

(P2-52) Design Consideration of Multipactor Phenomena Based on S-band Diplexer for Satellite Applications
Seung-Woon Choi, Day-Young Kim, Ki-Ho Kwon, Tae-Byeong Chae, Jong-In Lee(KARI)

ABSTRACTS

Ⅰ. ORAL PRESENTATION

Wednesday, 27 October

Invited Talk

The Evolving Sun and its influence on Planetary Environments ····· 46

Astronomy Ⅰ

Shocked Gas in the Galactic Center Molecular Cloud, Sgr B2 ····· 47
Mass Distribution in the Central Few Parsecs of Our Galaxy ····· 48
FIMS Observations of Hot Interstellar Medium ····· 49
Detection of H2 Fluorescence in Eridanus Region with FIMS ····· 50
GALEX Observations for the Look-back Time Evolution of Far-UV Flux from Elliptical Galaxies ····· 51
Detection of Van Hoof effect in RR Lyrae stars from BOES Observations ····· 52
Pulsations in Algols current status of researches ····· 53

Vehicle & Payload

Flight Software Development for KoDSat ····· 54
Vehicle Dynamics Simulator Development based on the Real-Time ····· 55
Conceptual Design of Small Mass Measuring Device in Micro-gravity ····· 56
Design of CTE Measuring Device for High-Resolution Telescope Structure ····· 57
Optimized Configurations of Ka-Band Transponder Subsystem for ETRI's SATCOM System ····· 58
Real-Time Orbit Determination Technique using Input Estimation Filter Algorithm for Geo-stationary Satellite ····· 59
IO Board Design of Next Generation Satellite using the Space Wire Interface ····· 60

Thursday, 28 October

Invited Talk

How Earth's inner and middle magnetosphere work ····· 61

Astronomy Ⅱ

Transformation of Extinction Values near the K-Band ····· 62
Stellar abundance patterns. From quantity to qaulity ····· 63
CREAM: Cosmic Ray Balloon Mission in Antarctica ····· 64
Optimal Deflection of Earth-Crossing Asteroids Using Laser Energy ····· 65
Grinding Optimization Model for Nanometric Surface Roughness for Aspheric Astronomical Optical Surfaces ····· 66

Astronomy Ⅲ

A Method for Testing Surface Deforms of Large Convex Mirrors ····· 67
Fabrication of Nb/Al Superconducting Tunnel Junction as a Novel Astronomical Detector ····· 68
Development Study of Local Oscillator System for mm-wave Radio Receiver ····· 69
Design of KAO Near Infrared Camera System on the SOAO 0.6m Telescope ····· 70

Satellite Orbit I

Orbit Propagation Software for Mars Orbiting Spacecraft ····· 71
DSN Measurement Model Development for Interplanetary Navigation ····· 72
Dynamic Model Development For Interplanetary Navigation ····· 73
Optimal Trajectory Design For Human Outer Planet Exploration ····· 74
Development of Precision Attitude Determination System for KOMPSAT-2 ····· 75
Developnent of the KOMPSAT-2 Satellite Mission Control System ····· 76
A study on Initial conditions for Satellite Formation Flying using State Transition Matrix ····· 77
Development of Sun-Glint Prediction Program For The Communication, Ocean and Meteorological Satellite ····· 78
Estimation of Solar Radiation Pressure on the Geostationary Satellite with a Single Solar Array Configuration ····· 79

Space Science Ⅰ

Compelling Evidence Supporting the Boundary Layer Dynamics Model of Substorms ····· 80
Large-Scale Geomagnetic Disturbances Driven by Solar-Wind Discontinuities ····· 81
Characteristics of geosynchronous particle flux disturbances caused by the solar wind dynamic pressure enhancement ····· 83
KAO Space Weather Monitoring System: I. Overview ····· 84
Development of the Technology to locate and to observe Solar Bursts ····· 85
Interaction of the Magnetic Cloud and the Interplanetary Shock with Cosmic Rays ····· 86

Space Science Ⅱ

Space Weather Studies at Kyushu University ····· 87
Spacecraft observations of ULF waves ····· 88
The Plasmasphere, and a Model for Plasmaspheric Density on 29 August 2000 ····· 89

Space Science Ⅲ

Plasma Wave Coupling in Inhomogeneous Space: A New Approach ····· 90
The Predictability of the Magnetosphere and Space Weather ····· 91
Study on the Geosynchronous Relativistic Electron Events ····· 92
A case study to determine the relationship of relativistic electron events to substorm injections and ULF powers ····· 93

Friday, 29 October

Invited Talk

IGS: Services for Science and General Public ····· 94

Satellite Orbit Ⅱ

Operational Orbit Determination Using GPS Navigation Data ····· 95
GPS based prediction of the Instantaneous Impact Point for KSLV-I ····· 96
LEO Satellite orbit maneuvers for increasing resolution of space image ····· 97
Covariance Analysis of Two Spacecraft System Using Relative Line of Sight Vector Measurements ····· 98
Formation Trajectory-Planning using Nonlinear Programming and Collocation ····· 99
Determination of Tropospheric Slant Wet Delay Using GPS ····· 100
Station-Keeping Maneuver Simulation for the communication Ocean and Meteorological Satellite ····· 101
A Reduced Dimensional Gimbal Rate Steering Law for Singularity-Free Control ····· 102
Dynamic Compensation in Measurments and Identification of Reaction Wheel Disturbance Model ··· 103

Satellite Management

Design and Implementation of On-Board Computers For STSAT-2 ····· 104
Calibration and Error Analysis of Performance Test Equipments for Sun Sensor ····· 105
Research of Proton Irradiation Effect by Ground Based MC-50 Cyclotron for Spacecraft's Shielding of Polyimide Kapton ····· 106
Development of A Photogrammetry System for Use under Thermal Vacuum Environment ····· 107
Thermal System Design for a Large Space Simulator (Φ8mXL10m) ····· 108
Evaluation of the Measurement Noise and the Systematic Errors for the KOMPSAT-1 GPS Navigation Solutions ····· 109
Korea Astronaut Mission Proposal with Analyzing Astronaut Missions of European Space Agency ····· 110
The Selection Criteria of Korean Astronauts ····· 112

Ⅱ. POSTER PRESENTATION

27 October 15:00 ~ 28 October 12:00

Astronomy

Eclipsing Binaries, The primary Distance Indicator ····· 114
Star Formation in the Large Magellanic Cloud ····· 115
CCD Photometry Using Multiple Comparison Stars
Distance and accreton luminosity of the long-period eclipsing polar V1309Ori ····· 115
Simulations of the photospheric convection in subgiant stars ····· 117
FIMS Observations of The Monogem Ring ····· 118
Absolute Parameters of a eclipsing binary AG Virginis ····· 119
The effects of α-element enhancement on isochrones; A detailed analysis ····· 120
CO to H2 ratio of interstellar molecular cloud ····· 121
Low Mass Ratio Contact Binary V410 Aur and V776 Cas ····· 122
Chemical Enrichment and Star Formation Histories of the Sextans Dwarf Spheroidal Galaxy ····· 123
Observation of molecular hydrogen fluorescence in the Taurus region by FIMS ····· 124
A new pre-data reduction program for the array On-The-Fly observations ····· 125
Dynamical Substructures of Galactic Globular Clusters ····· 126
The spectral analysis of the dayglow limb scanning data of FIMS in STSAT1 ····· 127
The Radial Velocity Study of the Near Contact Binary BX Andromedae ····· 128
The present status and research activities of the International Virtual Observatory Alliance ····· 129
Hydrodynamic Simulations of the 200-pc Molecular Ring ····· 130
BOES Spectroscopic Study of the Accretion Flow in the Symbiotic Star V1016 Cyg ····· 131
Light Element And Ni Abundance In Field Metal-Poor Stars ····· 132
Surface Brightness Fluctuations in GALEX UV Passbands as Population Indicators ····· 133
Eclipsing Binaries in the Central Bar of the Large Magellanic Cloud ····· 134
Accurate Absolute Dimensions and Distances of 10 Eclipsing Binaries ····· 135
First Multi-color Light Curves of V473 Cas ····· 136
Acoustic p-mode spacing and splitting in enigmatic rapidly-oscillating chemically peculiar magnetic star HD101065 (Przybylski's star) ····· 137
Distance and accreton luminosity of the long-period eclipsing polar V1309Ori ····· 138
Chemical Abundances for Seven Giant Stars In M68 (NGC 4590) ····· 139

History of Astronomy

The Solar Eclipse Predictions of Chiljeongsan-Oepyeon in Choseon Dyn. ····· 140
The research of five planets diagrams in the Jegdo-nambuk-chongseongdo ····· 141
Accuracy of Gnomonic Measurements in Korea and China ····· 142
Astronomical Observation as a practical experience learning program ····· 143

Astronomical Instruments

OECD Global Science Forum Near Earth Object International Steering Committee Progress Report ····· 144
A study of mechanical design and thermal analysis of KAONICS

(KAO Near-Infrared Camera System) ····· 145
Optical Alignment of KAO Wide Field Telescope (NEOPAT) ····· 146
Automatic observaton and control system with MEADE LX 200 ····· 147
Optics Design of the KAO Near Infrared Camera System (KAONICS) ····· 148

Space Science

CME geoeffectiveness according to its orientation and chirality ····· 149
High-latitude Thermospheric Winds and Momentum Forcing: Dependence on the I
nterplanetary Magnetic Field ····· 150
Conversion of Ordinary Waves into Upper Hybrid Waves in Inhomogeneous Plasmas ····· 151
Propagation of Nonlinear Magnetosonic Waves ····· 152
Solar Wind Dynamic Pressure during Magnetic Storms and Its Implications on the
Dayside Ring Current Particle Loss ····· 153
The effect of slow recombination of H3+on the Jovian ionosphere ····· 154
Effects of heavy ions on ULF waves in the magnetosphere ····· 155
The correlation between solar EUV flux and plasma characteristics in the
low-latitude topside ionosphere at nighttime ····· 156
KAO space weather monitoring system: II. Real-time data acquisition tools and applications ····· 157
KAO Space Weather Monitoring System: III. Nowcast, Forecast and Database ····· 158
Equatorial Plasma Bubbles in the Premidnight Sector During Solar Maximum as
Observed by KOMPSAT-1 ····· 159
The ionospheric variation of radio waves on the Korea Peninsula ····· 160
A statistical study of solar wind dynamic pressure enhancements during geomagnetic storms ····· 161
The effect of dust particles on ion acoustic solitary waves in a dusty plasma ····· 162

Satellite

Angles Only Orbit Determination From Single Tracking Station ····· 163
Launch Stage Thermal Analysis for Satellite Box Under Two Extreme Thermal Conditions
By Using Analytical Approach ····· 164
Service & Network Operation of The Multibeam Switching Satellite Communications System ····· 165

Vehicle

Development of Performance Simulation Software for Satellite Reaction Control Thruster ····· 166

28 October 12:00 ~ 29 October 12:00

Vehicle

Basic Design Analysis of Rocket Test Facility for KSLV Propulsion Unit ····· 167
The Cryogenic Regulator Design for Liquid Propulsion System ····· 168
A Conceptual Design for Electrical Grounding Architecture of Korean Space Launch Vehicle ····· 169
Development of Tracking Systems Applicable To Space Launch Vehicle ····· 170
A Study on the Prediction of the Base Flow Characteristics of a Launch Vehicle Using CFD ····· 171

A Study on Degreasing Detergent and Method for the IPP test facility ····· 172

An Investigation on the Performance of a Propulsion System with the Branch Location of an Oxidizer Feeding Line ····· 173
Anaysis of Engine Starting Mode with a Pyro-Starter ····· 174
Residual Propellant Gauging Method Using Thermal Pumping of Multi-tanks Satellite System ····· 175
Explicit Guidance Thrust Integrals Derivation for a Launch Vehicle With Varying Thrust ····· 176
Design and Functional test of On-board Flight Analog Video System ····· 177
An Analytical Study on the Dynamic Characteristics of a Liquid Propulsion System ····· 178
Shock Wave Boundary Layer Interaction Studies In Corner Flows ····· 179
An analysis of thrust and specific impulse of the Liquid Rocket Engine according to the change of chamber pressure and the flight height ····· 180
The Variation of System by Density-Drop of Propellants in LRE ····· 181
The dynamic analysis of a thruster system in a Satellite launch vehicle ····· 182
Tank Depletion System for Space Launch Vehicle ····· 183
Introduction of the Program Life-cycle Management System for Space Launch Vehicle Development ····· 184
Reliability Demonstration of Propulsion System of Space Launch Vehicle ····· 185
Ascent Thermal Analysis of Fairing of Space Launch Vehicle ····· 186
Prelaunch Thermal Analysis of KSLV-I Payload Fairing ····· 187
Development of Thermal Control System for Cryogenic Environment of Launch Vehicle ····· 188

Satellite

Current Status of STSAT1 Satellite by on-Orbit Log Information ····· 189
The Implementation Method and Test of Telemetry Trend Analysis in KOMPSAT-2 ····· 190
Error Analysis of SEE qualification for C860 Microprocessor ····· 191
A Proposed High Availability Architecture for Coms Ground Control System ····· 192
Efficient Thermal Modeling In Development of a Spaceborne Electronic Equipment ····· 193
Design and Implementation of Telemetry Interface for KSLV-I ····· 194
K-2 Bus Platform Evaluation Based on The Analysis of RF System Characteristics ····· 195
Bus System Evaluation by Conduction Noise Injection ····· 196
Calibration of Image Geolocation by Thermal Distortion Map ····· 197
The Conceptual Design of a Power Control and Distribution Unit for the Next Generation Satellite ····· 198
Design of a Scalable Power Bus Regulator for PCDU of Satellites ····· 199
The MPPT Design for Small Satellite in LEO ····· 200
Unit Modeling For Conducted Emission Noise Analysis of a Satellite System ····· 201
The Analysis on Space Radiation Environment of STSAT-2 ····· 202
A Comparison of Thermal Math Modelings for Power Cable in Space Environment Simulation ····· 203
Ka-band Antenna Performance Analysis of COMS Satellite ····· 204
A Position Tracking Algorithm with Radar Measurement ····· 205
Satellite Operation Plan at Launch Site for Launch Preparation ····· 206
Front End Telemetry Data Acquisition Unit for KSLV-I Upper Stage ····· 207
KOMPSAT-2 RF Compatibility Test for S-Band ····· 208

A Study on Thermally Induced Dynamics of the Geostationary Satellite with a Single Solar Array ····· 209
A Comparison Study of Space Radiation Dose Analysis Programs: SPENVIS Sectoring Tool and SIGMA II ····· 210
Design of Common EGSE & EGOE System for Satellite Test & Mission Control Element ····· 211
Environmental Test of the EQM Payload System for the Communications and Broadcasting Satellite ····· 212
The Design of System Software - EXEcutive CSC for KOMPSAT-2 ····· 213
Comparison of Numerical Prediction with Test Results at Space Thermal Simulation Test ····· 214
Thermal Design on Satellite Payload Fixture for Space Simulation Ground Test ····· 215
Thermal Analysis for Space Simulation Test Preparation ····· 216
Vertical Ozone Density Profiling by UV Radiometer onboard KSR-III ····· 217
Design Consideration of Multipactor Phenomena Based on S-band Diplexer for Satellite Applications ····· 218

The Evolving Sun and its influence on Planetary Environments

Edward Guinan
edward.guinan@villanova.edu
Dept. of Astronomy and Astrophysics
Villanova University

Studies of young solar proxies (G0-G5 V stars), as part of the ''Sun in Time'' program, show that the young Sun was rotating over 10× faster than today. As a consequence, these young solar type stars (including the young Sun) had vigorous magnetic dynamos and correspondingly strong coronal X-ray and EUV emissions and chromospheric FUV and UV emissions - up to a thousand times stronger than that observed for the present Sun. Also, observations of the youngest solar proxies indicate that the young Sun had frequent and powerful flares and most likely strong winds. The results of the ''Sun in Time'' program will be discussed that show the decline of solar coronal and chromospheric activity with slower rotation and increasing age. Also discussed are some of the major effects that the young Sun's strong magnetic activity may have had on the photoionization, photochemistry, and erosion of paleo-planetary atmospheres. Some examples that will be briefly discussed include: the possible erosion of Mercury's mantle, loss of water on Mars and the oxidation of its surface, hydrodynamic mass loss from paleo planetary atmospheres, and the evolution of the Earth's atmosphere and the origin and evolution of life

Shocked Gas in the Galactic Center Molecular Cloud, Sgr B2

Y. C. Minh
Korea Astronomy Observatory

The Sgr B2 molecular cloud, which locates at about 200 pc from our Galactic center, represents a relatively extreme case of high luminosity star formation taking place in a very massive giant molecular cloud. We have observed the transitions of H_2S and SiO, which are known as shock tracers, toward Sgr B2, using the SEST radio telescope at Chile. Emissions from these molecules appear to be strongly concentrated to the prominent star forming core, Sgr B2(M). We discuss on the chemical characteristics of the region traced by these molecules, especially, in connection with sulfur and silicate chemistry and their chemical models.

Mass Distribution in the Central Few Parsecs of Our Galaxy

Seungkyung Oh[1], Sungsoo S. Kim[1], Donald F. Figer[2] and Mark Morris[3]

[1]Kyung Hee University, [2]STScI, [3]UCLA

Near-IR observations of the central few parsecs of our Galaxy from the HST/NICMOS have been analyzed to produce H, K photometry. Adopting the Gemini K_{cont} and CO band observation, we distinguish evolved late-type stars from early-type stars, and use late-type stars as tracer population. We perform several statistical tests to find the best fitting parameters of stellar density distribution and velocity dispersion models. The volume number density distribution has power law index 1.55~1.7. We then derive the mass distribution in the Central region of our Galaxy using the Jeans equation.

FIMS Observations of Hot Interstellar Medium

Kwang-Il Seon[1], I.-J. Kim[1,2], J.-H. Park[1], J.-H. Shinn[2,3], D.-H. Lee[1], K.-S. Ryu[2], W. Han[1], K.-W. Min[2], H. Jin[1], I.-S. Yuk[1], U.-W. Nam[1], J. Edelstein[3], K. Nishikida[3] and E. Korpela[3], J. Kregenow[3]

[1]Korea Astronomy Observatory
[2]Korea Advanced Institute of Science and Technology
[3]Space Sciences Lab., University of California, Berkeley

We present far-ultraviolet spectral observations of highly ionized interstellar medium including supernova remnants and soft X-ray shadows, observed with FIMS (Far ultraviolet IMaging Spectrograph; also known as SPEAR) onboard the first Korean scientific satellite, STSAT-1. The emission lines observed with FIMS include C IV, He II, C III, O III], O IV, Si IV and O VI. The emission lines arise in thermally heated or shocked gases and in conductive interfaces. The global spectral images of two supernova remnants, Cygnus Loop and Vela supernova remnants, are presented.

Detection of H_2 Fluorescence in Eridanus Region with FIMS

Kwangsun Ryu[1], Kyoungwook Min[1], Jerry Edelstein[2], Wonyoung Han[3], Jongho Shin[1], Daehee Lee[3], Kwangil Seon[3], Ukwon Nam[3], Janghyun Park[3], Iljung Kim[1], Eric Korpela[2]

[1]Korea Advanced Institute of Science and Technology
[2]Space Sciences Lab., University of California at Berkeley
[3]Korea Astronomical Observatory

FIMS (Far ultraviolet IMaging Spectrograph) instrument is an imaging spectrograph on the STSAT-1 (Science and Technology Satellite-1) spacecraft with band passes of 900-1150 (short wavelength band) and 1350-725Å′s (long wavelength band). Several targets were observed for the purpose of instrumental calibration and performance demonstration from December, 2003 to January, 2004. During the time, the Eridanus region was observed to get spectral image of emissions from the interstellar matter known to be created and excited by supernova explosion, stellar winds, and strong UV radiation from an O/B association. In the long wavelength band, distinct fluorescent emission features of the hydrogen molecule were detected in the region whose spectrum is fit with a fluorescent emission model associated with PDR (photon dissociation region). The comparisons with a model prediction show that the spectral features are not only the consequence of the photon excitation on molecular clouds but also of the heating and excitation by the shocks passing the region. According to the spectrum analysis and emission model studies, the FUV emission of H$_2$ molecules from the Eridanus supershell implies the preexisting molecular clouds in the region is swept and heated by interstellar shocks up to $\sim2,000\pm1,000$ K and then is being exposed to strong radiation field from the Orion O/B association.

GALEX Observations for the Look-back Time Evolution of Far-UV Flux from Elliptical Galaxies

Chang H. Ree[1], Young-Wook Lee[1], Young-Jong Sohn[1], Soo-Chang Rey[2], Jaehyon Rhee[1], Sukyoung K. Yi[1,3], Suk-Jin Yoon[1,3], Jae-Woo Lee[4], Sug-Whan Kim[1], and GALEX Science Team

[1]Center for Space Astrophysics, Yonsei University
[2]Department of Astronomy and Space Science, Chungnam National University
[3]Department of Physics, University of Oxford
[4]Department of Astronomy and Space Sciences, Sejong University

In order to investigate the origin of the far-UV (FUV) flux from the early-type galaxies, GALEX (Galaxy Evolution Explorer) is currently observing elliptical rich clusters at moderate redshifts ($z < 0.2$) where the dominant FUV source is predicted to be hot horizontal-branch (HB) stars and their post-HB progeny. Here we present our first result for the early-type galaxies in Abell 2670 at $z = 0.076$. Compared to NGC 1399, a nearby giant elliptical galaxy in the Fornax cluster, it appears that the rest-frame (FUV - V) color of the giant ellipticals gets redder by ~ 0.7 mag at the distance of Abell 2670 ($z = 0.076$; look-back time $\approx$ 1.0 Gyr). Although a detailed comparison with the models is postponed until more cluster data are accumulated, it is interesting to note that this value is consistent with the variation predicted by the population synthesis models where the mean temperature of HB stars declines rapidly with increasing look-back time.

Detection of Van Hoof effect in RR Lyrae stars from BOES Observations

Hak-sub Kim and Yong-Ik Byun
Dept. of Astronomy and University Observatory, Yonsei University

The Van Hoof effect, a phase lag between hydrogen and metallic line, has been interpreted as the propagation time of the pulsation wave through the atmosphere of pulsating stars. The Van Hoof effect between hydrogen and metallic lines was observed for the first time by Mathias (1995), but he couldn't detect similar effect between metallic lines. On the other hand, Chadid (1998) argues that the Van Hoof effect exists not only between hydrogen and metal line but also between some metallic lines. In order to investigate the existence of the Van Hoof effect in RR Lyrae stars, we observed three RR Lyrae stars using BOES at the Mt Bohyun 1.8-m telescope. Velocity curves of HI, OI and 8 metal elements were derived from high resolution spectra. The accuracy of velocity determination was measured against telluric lines and turned out to be better than 1 km/s in all wavelength domain. From the velocity-velocity diagram, we detect very clear sign of Van Hoof effect between hydrogen and metallic lines. We also find velocity-velocity correlation that can be considered as the Van Hoof effect between selected metallic lines.

Pulsations in Algols current status of researches

David E. Mkrtichian
Astrophysical Research Center for the Structure and Evolution of the Cosmos, Sejong University

The review presents the current status of researches of pulsating components in semi-detached (Algol-type) systems. I will show the important preferences of the pulsation mode identifications in eclipsing binaries in respect to a single stars. On example of well-studied systems I will show effects of the gas-stream and circum-stellar accretion envelope on the orbital modulation of the pulsation radial velocity amplitudes that can be used for mode-identification and study of gas envelope spatial density. The influence of rapid mass-transfer episodes on short-term and long term stability of pulsations will be discussed and several examples of pulsational observables that can be used to glean valuable information about the binary system and its evolutionary status will be suggested.

Flight Software Development for KoDSat

Eun-Jung Choi, Suk-June Park, Jang-Soo Chae and Tae-Sik Oh

Space Development & Research Center, Korea Aerospace Industries

The KoDSat(KSLV-1 Demonstration Satellite) system performs primary mission for acquiring the vibration & acoustic data from KSLV-1(Korea Space Launch Vehicle-1), the separation images from fairing and the orbit insertion accuracy.

The KoDSat Flight Software execute in single-computer the spacecraft, the OBC(On-Board Computer). The software resides on 80386 processor and communicates the payload via RS-422. The software controls the hardware and instruments of the spacecraft, gathers the data from DAU(Data Acquisition Unit) and GPS(Global Positioning System) and transmits to the Ground System. To acquire the many data from the unis via RS-422, OBC executes the PingPong Buffering System. PingPong Buffering system stored the maximum 2 Kbytes via RS-422 and occurs the interrupts. When the interrupt occurs, the flight software gets the data, packetize the CCSDS Format and stores the Mass Memory.

The KoDSat Flight Software completes critical detail design and is testing in the ETB(Engineering Test Bed).

Vehicle Dynamics Simulator Development based on the Real-Time

Young-woong Park, Cheol-hea Koo, Bong-kyu Park
Communication Satellite Systems Department of Communication Ocean and Meteorological Satellite Program Office, Korea Aerospace Research Institute

In this paper, the results verified the performance of the satellite model, AOCS component models and the algorithm in FSW are introduced using the engineering simulation and the PILS. All model is based on Koreasat-3. Each of the models and the control algorithm are constructed of the modular type which is divided by the independent function. So it is easy to add other new model or to reject the existed model. The PILS is developed to be possible the multi-tasking and real-time processing. That is, each model can process independently but has the limit of the each processing frequency. The essential data of the each model are shared using 'mutual semaphore' and the data between the VDS and the FSW are communicated by MIL-1553B cable and its protocol.

Conceptual Design of Small Mass Measuring Device in Micro-gravity

Jong-Woo Kim, Youn-Kyu Kim, Ki-Hyeok Choi, Ju-Hee Lee, Hae-Jin choi

Satellite Mission Operation Department, Korea Aerospace Research Institute, Daejeon, Korea

The Small Mass Measuring Device(SMMD) is an instrument that can accurately determine the masses of solid, semi-solid, and liquid materials(including live specimens), in micro-gravity. This paper proposed three methods and measuring algorithms which are using Inertia Force and Standard Mass, using Frequency Shift Detecting of Vibrator, and using centrifugal force and Standard Mass. This paper introduce the diagram and measuring flow of proposed methods. We will present the detail methods and logical explanation at the next opportunity.

Design of CTE Measuring Device for High-Resolution Telescope Structure

Jong-Min Im, Hong-Bae Kim
Space Test Div./Space Test Dept.KOMSAP Program Office,
Korea Aerospace Research Institute

The telescope structure used in the satellite consists of PM(Primary mirror), SM (Secondary Mirror), detector and structure part and operates relatively severe environmental conditions. For example, MSC(Multi Spectral Camera) in KOMSAT-Ⅱ, which is developed by KARI, is designed to operate at the temperature range of -20℃~55℃. These temperature variations during the orbit operation lead to the thermal expansion or extraction of each structural components. These thermal deformations could have a serious effect on the performance of telescope. Therefore, the telescope structure has to be designed to minimize the deformations to the temperature variations. This characteristic is expressed as the dimensional stability. For the telescope used in the satellite, if it is sent to the space, the modification or adjustment is impossible. So, on-ground verification of stability should be performed for the developed telescope model under the same conditions of the space. In this paper, for the verification of performance of the high resolution telescope, the preliminary design of CTE measuring device is to be presented, which can verify the dimensional stability in the laboratory.

Optimized Configurations of Ka-Band Transponder Subsystem for ETRI's SATCOM System

Yong-Min Lee, Seong-Pal Lee, Jae-Woo Park
Communication Satellite System Research Team
Communication Satellite Research Group
Electronics and Telecommunications Research Institute (ETRI)

In order to optimize the configurations of Ka-band transponder subsystem, the trade-off design has been performed iterately with emphasis on the improving performances of the payload system as well as effectiveness of Satellite Communication (SATCOM) system operation. It is necessary to allocate performance to the transponder equipments and to keep providing the main services. It begins with analyzing the requirements and allocating performance parameters by establishing budgets for electrical and mechanical characteristics. In this paper, introduction of SATCOM system and finally optimized Ka-band transponder configuration that is to be used for preliminary design will be mainly presented.

Real-Time Orbit Determination Technique using Input Estimation Filter Algorithm for Geo-stationary Satellite

Bang-Yeop Kim, Bong-Kyu Park, and Sang-Cherl Lee
Communication Satellite Systems Department, KARI

We examined the applying of Input Estimation Filter (IEF) algorithm to the real-time orbit determination for a geo-stationary satellite. Generally, the Extended Kalman Filter (EKF) algorithm has been used to the real-time orbit determination in satellite operation. The EKF algorithm is good for the general non-linear estimation problem and robust to the geo-stationary orbit determination during the non-maneuvering period. But when the orbital maneuvers were occurred, the ordinary EKF shows some large errors. The IEF algorithm has been used to the missile for the tracking of maneuvering target. This algorithm assumes that the target can shows irregular maneuvering motion any time and configures a bank of filters. The filters in the bank generate many possible estimated statuses and compare to the EKF solution, and the best estimated status were adapted and updated finally. In this paper, we are going to show the simulation results of the real-time orbit estimation output using EKF only and with IEF algorithm. Through the comparing the results we could expect that the IEF algorithm can increase the estimation accuracy especially when the north-south stationkeeping maneuver.

IO Board Design of Next Generation Satellite using the Space Wire Interface

Ki-Ho Kwon, Day-Young Kim, Seung-Woon Choi, Jong-In Lee
Satellite Electronics Department, Satellite Technology Division,
Korea Aerospace Research Institute(KARI), Daejeon, 305-333, Korea
E-mail: khkwon@kari.re.kr

This paper presents a feasibility study of an advanced IO board design for the next generation of low-earth orbit satellites. Advanced IO board design includes sensor interface, A/D, D/A, Digital Module, Serial Module etc, and allows to process increasing data rates between IO board and CPU board. The higher data rate involved in modern IO board additionally introduce issues such as noise, fault tolerance, command and data handling, limited pin count and power consumption problems. The experience in KOMPSAT-1 and 2 program with this kind of problems resulted in using SMCS chip set, a high speed serial link technology based on IEEE-1355(Space Wire Protocol)[1,5], as a standard for next generation of satellite IO board design.

How Earth's inner and middle magnetosphere work

R. A. Wolf
Physics and Astronomy Dept., Rice University,
Houston, Texas, U.S.A.

The Large-scale mechanics of Earth's inner and middle magnetosphere will be reviewed in a tutorial style. An attempt will be made to summarize present understanding and to point out major unresolved issues. Topics to be covered include the inner plasma sheet, ring current, and plasmasphere and their coupling to the ionosphere, particularly during magnetic storms. Considerable emphasis will be placed on the dynamics of the electric field in both magnetosphere and ionosphere. The presentation will be mainly theoretical and will make heavy use of simulations carried out with the Rice Convection Model and related computer codes. Relevant observations will also be discussed, with particular emphasis on the pictures of the plasmasphere and ring current that have been obtained in the last few years with the IMAGE spacecraft.

Transformation of Extinction Values near the K-Band

Sungsoo S. Kim
Kyung Hee University, Dept. of Astronomy and Space Science

We calculate theoretical isochrones in a consistent way for five filters near the K-band, K, K′, K_s, F205W, and F222M. Even when displayed in the same Vega magnitude system, the near-infrared colors of the same isochrone can differ by up to 0.18 mag at its bright end, depending on the filter. We analyze isochrones for several different extinction values, and find that a care is needed when comparing extinction values that are estimated by different filter sets, in particular when comparing those between atmospheric and space filter sets. To alleviate this problem, we present an "effective extinction law" for each filter set and isochrone model, which describes extinction behaviour of isochrones in the observed color-magnitude diagram.

Stellar abundance patterns. From quantity to qaulity.

Alexander Yushchenko
Astrophysical Research Center for the Structure and Evolution of the Cosmos Sejong University, Korea

Modern big telescopes, high-resolution spectrographs, receivers, software and atomic data permit to find the abundances of 50-60 chemical elements in the atmospheres of sharp-lined stars. Abundance patterns of this size permits to make a qualitative step in the investigations of stellar spectra. We present a review of the detailed abundance determinations in Procyon (55 elements), Sirius (50 elements), mild barium star zeta Cyg (51 element), delta Sct (52 elements), Przybylski's star(>60 elements), thorium rich halo star HD221170 (43 elements), SB2 system HD153720 (23 elements) and new astrophysical results obtained from these data. Results are based on observations obtained at 2-m telescope of Terskol Observatory, 2.7-m McDonald telescope, 3.6-m ESO telescope and VLT.

CREAM: Cosmic Ray Balloon Mission in Antarctica

J.Yang[1],H.J.Hyun[1],I.H.Park[1],J.A.Jeon[1],J.H.Han[1],J.K.Lee[1],M.Y.Kim[1],N.H.Park[1],S.J.Baek[1],S.W.Nam[1],H.B.Park[2],H.J.Kim[2],Y.J.Kim[2],K.W.Min[3],K.I.Seon[4],W.Han[4],W.Nam[4],H.S.Ahn[5],O.Ganel[5],M.H.Lee[5],L.Lutz[5],A.Malinine[5],E.S.Seo[5], S.Y.Zinn[5]

[1]Depart.of Physics, Ewha Womans University, [2]Depart. of Physics, Kyungpook University, [3]Depart. of Physics, Korea Advanced Inst. of Sci. and Tech. [4]Korean Astronomy Observatory, [5]The University of Maryland

The Cosmic Ray Energetics And Mass (CREAM) instrument is configured with stateof-the-art particle detectors to measure cosmic ray composition from protons to iron nuclei over the energy range 1 - 103TeV in a series of balloon flights. The goal is to observe cosmic-ray spectral features and/or abundance changes that might signify a limit to supernova acceleration. The science instrument will be integrated with a flight support system developed for 100-day flights. Particle charge (Z) measurements will be made with a timing-based detector and a pixelated silicon matrix to minimize the effect of backscatter from the calorimeter. Particle energy measurements will be made with a transition radiation detector for Z >3 and a sampling Tungsten/scintillator calorimeter for Z 1. In-flight cross calibration of the two detectors allows better determination of the particle energy. Measurements of relative abundances of secondary cosmic rays (e.g., B/C) as well as primary spectra will allow determination of cosmic ray source spectra at this high energy, where measurements are currently not available. The instrument has been tested and calibrated with a series of beam tests at CERN. The first flight is planned to be launched from Antarctica in December 2004 on a zero pressure balloon. Using two instrument suites, we plan to conduct annual flights on a zero pressure balloon until ultra long duration balloons become available. The status of the instrument suites and the flight plans will be reported.

Optimal Deflection of Earth-Crossing Asteroids Using Laser Energy

Byeong-Hee Mihn, Sang-Young Park, and Kyu-Hong Choi
Dept. of Astronomy and Space Science, Yonsei University, Seoul

There are space collision events like the Shoemaker-Levy9 comet with Jupiter in July 1994, as well as about 100 terrestrial impact craters. In this study, a continuous optimization problem is formulated to calculate the optimal laser energy for deflecting Earth-Crossing Asteroids(ECAs). The direct collocation technique is used for adopting a nonlinear programing. The continuous laser energy is provided to change the ECA's velocity for avoiding impact to the Earth. The nonlinear constraints of the optimization problem are based on the Hermite-Simpson's equations and the three-dimensional patched conic approximation including the Earth's gravitational effects. The optimal duration of lasing 0.1~1.0 km-class ECAs is estimated for various deflecting scenarios. The analysis performed in present paper can be practically applied to deflection missions by using spacecraft with limited power.

Grinding Optimization Model for Nanometric Surface Roughness for Aspheric Astronomical Optical Surfaces

Jeong-Yeol Han[1,2], Sug-Whan Kim[3], Geon-Hee Kim[4], In-Woo Han[2] and Ju-Whan Kim[4]

[1]Dept. of Astronomy and Space Science, University of Science and Technology

[2]Optical Astronomy Division, Korea Astronomy Observatory

[3]Space Optics Laboratory, Dept. of Astronomy and Space Science, Yonsei University

[4]Ultra-Precision Engineering Laboratory, Korea Basic Science Institute

Bound abrasive grinding is used for initial fabrication of the aspheric mirror for both space and ground based astronomical telescopes. In this paper, we determine the grinding parameters before grinding, trace the predict error of surface roughness during grinding, and reduce the elapsed time. We set the target surface roughness from 96.1 ~ 65.0 nm using multi-variable regression analysis method before grinding and predicted the measured surface roughness after grinding. Experiments shown the measured surface roughness from 97.4 to 64.0 nm in height and the predict accuracy of target surface roughness down to ± 5 nm in height can be reached using our model. This study developed the process optimized technique to minimize the period and cost of production against the traditional qualitative experiences as we grind the astronomical optical surfaces.

A Method for Testing Surface Deforms of Large Convex Mirrors

Young-Soo KIM[1,2]

[1] Korea Astronomy Observatory

[2] Korea Institute of S&T Evaluation and Planning

Both ground and space telescopes are being built larger and larger. Accordingly, the secondary mirrors become larger which are convex mostly on the surface form. Testing convex mirrors becomes more difficult and delicate than testing concave mirrors in optics, because additional optical components are needed to make the reflected rays converge. Hindle type tests are frequently used for measuring the surface deforms of convex mirrors, which employs a meniscus lens to reverse the diverted rays from the mirrors. In case of testing large convex mirrors by using Hindle type tests, attention would be needed as larger meniscus lens is required. A method of modified Hindle test has been studied and the characteristics are analyzed. In this talk, current methods of testing convex mirrors are presented, and the new method is discussed.

Fabrication of Nb/Al Superconducting Tunnel Junction as a Novel Astronomical Detector

Jang-Hyun Park[1], Young-Sik Park[1], Sung-Ik Cho[1,3]
Yong-Ho Lee[2], Sang-Kil Lee[2], Sug-Whan Kim[3], Wonyong Han[1]

[1]Korea Astronomy Observatory, Daejeon 305-348, Korea
[2]Korea Research Institute of Standards and Science, Daejeon 305-600, Korea
[3]Dept. of Astronomy and Space Science. Yonsei University, Seoul 120-123, Korea
E-mail: jhpark@kao.re.kr

We report the fabrication of a set of single pixel Nb/Al-based superconducting tunnel junction (STJ). The experimental junctions consist of various sizes of pixels (20, 40, 60, and 80 μm^2), and standard thin film making processes including UV photolithography and CVD (Chemical Vapor Deposition) techniques are applied for junction fabrication. Total 5 polycrystalline layers (Nb/Al/AlOx/Al/Nb) are deposited on a 2 inch silicon wafer. The junctions are cooled down to one tenth of the critcal temperature (~1 K for Nb junction) for normal operation. By measuring IV-curve, we can determin performance indicators such as energy gap, FWHM energy resolution, resistance, resistivity, etc. STJ technique offers attractive features for astronomical observation. They include : a) intrinsic wavelength discrimination, b) extremely broad spectral range, c) very high quantum efficiency, d) high time resolution. The usability and technical agenda of STJ as a novel astronomical detector will be discussed.

Development Study of Local Oscillator System for mm-wave Radio Receiver[1)]

C.H. Lee, S.T. Han, K.D. Kim, M.H. Chung, H.R. Kim
Taeduk Radio Astronomy Observatory, Korea Astronomy Observatory
36-1 Whaamdong, Yusung-gu, Daejon Korea, 305-348
E-mail: chlee@trao.re.kr

In this paper, we report the development and automation study planning of several local oscillator systems in other to compare the LO frequency and phase stability of each methods. This comparing study is very important to get the optimum quality of the observing law data. From this research we will be proposed the best solution to configure the LO system at mm-wave band. Especially this research will be focused to any focal plane array receiving system.

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Design of KAO Near Infrared Camera System on the SOAO 0.6m Telescope

Ho Jin[1], Soojong Park[1], In-Soo Yuk[1], Sungho Lee[1], Bongkon Moon[1,2],Jeong-Yeol Han[1,3],Kwag-Il Seon[1], Jina Kang[1], Kyung-Nam Kong[1,2], Wook-Won Nam[1], Dae-Hee Lee[1]

[1]Korea Astronomy Observatory

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

[3]Departmet of Astronomy and Space Science, University of Science and Technology

In order to extend the Sobaeksan Optical Astronomy Observatory (SOAO) observation capabilities to near infrared wavelengths, we are designing and manufacturing a 512 x 512 InSb offner re-imaging infrared camera. It is a first year to develope of this camera. Since the SOAO 0.6-m telescope is optimized for observations at visible wavelengths, the background rejection capabilities of the KAONICS cold stop and baffles are of critical importance for its sensitivity. An Offner relay is chosen for this reason and will be manufactured from the same melt of aluminum alloy to ensure homologous contraction from room temperature to 80 K. The DSP-based electronics will allow readout of the entire array with double-correlated sampling with other functions. In this presentation we report on the optical, mechanical, and electronic design concept of the system.

Orbit Propagation Software for Mars Orbiting Spacecraft

Young-Joo Song[1], Sung-Moon Yoo[1], Eun-Seo Park[1]
Sang-Young Park[1], Kyu- Hong Choi[1] Jae-Cheol Yoon[2],
Joon-Min Choi[2], Han-Dol Kim[2], Hak-Jung Kim[2], Byung-Kyo Kim[2]
[1]Dept. of Astronomy and Space Science, Yonsei University.
[2] Korea Aerospace Research Institute (KARI).

Orbit propagation software for the Mars orbiting spacecraft has been developed and verified, in preparations for the future Korean Mars missions. When a spacecraft is located in the vicinity of Mars, it is convenient to utilize Mars centered coordinate systems. Mars true equator is used as the reference plane and Mars International Astronomical Union (IAU) vector as the reference axis for Mars Centered Inertial (MCI) coordinate system. Mars prime meridian is also used as the reference axis to define Mars Centered Fixed (MCF) coordinate system. Coordinate corrections to the Mars centered system have been made to adjust the errors caused by Mars precession and nutation effects. After spacecraft enters Sphere of Influence (SOI) of the Mars, spacecraft experiences various perturbation effects as it approaches to Mars. Every possible perturbation effects are considered during integrations of spacecraft state vectors, including solar radiation pressure, Mars gravity field, Mars atmospheric drag, gravitational effects of Mars moon's (Phobos and Deimos), and nine solar planets with the Sun. To compute exact locations of other planets, JPL's DE405 ephemerides are used. Phobos and Deimos's ephemeris are computed using analytical method because their informations are not released with DE405. The Mars50c gravity field model and the MARS-GRAM 2001 model are used to compute perturbation effects due to Mars gravity field and Mars atmospheric drag respectively. Mars Global Surveyor's mapping orbital data are used to verify the developed propagator performances. One Martin day propagation (12 orbital periods) show about maximum ±5 meter errors, in every position state components, when compared to Astrogator propagation results from Satellite Tool Kit.

DSN Measurement Model Development for Interplanetary Navigation

Hae-Yeon Kim[1], Eun-Seo Park[1], Young-Joo Song[1], Kyung-Min Rho[1], Sung-Moon Yoo[1], Sang-Young Park[1], Kyu-Hong Choi[1], Jae-Cheol Yoon[2], Jo-Ryung Yim[4], Jun-Min Choi[3], Byung-Kyo Kim[3]

[1]Department of Astronomy and Space Science Yonsei University, Seoul 120-749, Korea

[2]Satellite System and Integration Department, Korea Aerospace Research Institude

[3]Satellite Basic Core System Department, Korea Aerospace Research Institude

[4]Satellite Control System Department, Korea Aerospace Research Institude

DSN(Deep Space Network) measurement model for interplanetary navigations which is essential for precise orbit determination has been developed. The DSN measurement model produces the real DSN observables such as range, doppler, angular data containing the potential observational errors in geometric data obtained from orbit propagator. So the important parts of this research are to model observational errors in DSN observation and to characterize the errors. The modeled observational errors includes the range delay effect caused by troposphere, ionosphere, antenna offset, and angular refraction effect caused by troposphere. The Hopfield, Modified Hopfield, Saastamonien, Neill, Chao, and D. L. Cani model are used for calculating the tropospheric range delay, and the two IRI(International Reference Ionosphere) models are used for the ionospheric range delay. The Lanyi and D. L. cani model are used for calculating the tropospheric refraction effect. Non-modeled errors are justified as the solved-for parameters. All of these results from error models show about 10% errors compared to the JPL's reference results, that is remained in acceptable error range.

Dynamic Model Development For Interplanetary Navigation

Eun-Seo Park[1], Sung-Moon Yoo[1], Young-Joo Song[1], Sang-Young Park[1], Kyu-Hong Choi[1], Jae Cheol Yoon[2], Jo Ryeong Yim[4], Byung Kyo Kim[3], Joon-Min Choi[3], and Seung-Woo Rhee[4]

[1]Department of Astronomy and Space Science, Yonsei University
[2]Satellite System and Integration Department, Korea Aerospace Research Institute
[3] Satellite Basic Core System Department, Korea Aerospace Research Institute
[4] Satellite Control System Department, Korea Aerospace Research Institute

The dynamic model for interplanetary navigation has been developed. The Cowell method of special perturbation theories was employed to develop an interplanetary trajectory propagator including the perturbations due to geopotential, the Earth's dynamic polar motion, the gravity of the Sun, the Moon and the other planets in the solar system, the relativistic effect of the Sun, solar radiation pressure, and atmospheric drag. The equations of motion in dynamic model were numerically integrated using Adams-Cowell 11th order predictor-corrector or Runge-Kutta 7-8th method. To compare the influences of each perturbation, trajectory propagation was performed using initial transfer orbit elements of the Mars Express mission launched in 2003. To investigate the applicability of dynamic model developed, the minimum distance from the spacecraft to the Mars at arrival time was tested, because the position of the spacecraft at arrival time must be within the SOI(Sphere of Influence) of the Mars. The interplanetary navigation tool developed in this study yields the spacecraft arriving distance within Mars SOI, hence, the spacecraft could arrive at the target planet. The results obtained are verified using the AGI Satellite Tool Kit. It is concluded that the program developed is suitable for supporting interplanetary spacecraft mission.

Optimal Trajectory Design For Human Outer Planet Exploration

Sang-Young Park[1], Hans Seywald[2], Shawn A. Krizan[2], and Frederic H. Stillwagen[3]

[1]Department of Astronomy and Space Science. Yonsei University
[2]Analytical Mechanics Associates, Inc., Hampton, VA 23666, USA
[3]NASA Langley Research Center, Hampton, VA 23681, USA

An optimal interplanetary trajectory design is presented for Human Outer Planet Exploration (HOPE) to visit Callisto, one of Jupiter's moons, by using an advanced magnetoplasma spacecraft. A detailed optimization approach is formulated to utilize Variable Specific Impulse Magnetoplasma Rocket (VASIMR) engine with capabilities of variable specific impulse, variable engine efficiency, and engine on-off control. To design a round-trip trajectory for the mission, the characteristics of the spacecraft and its trajectories are analyzed. Optimal trajectories are significantly depend upon relative geometric positions and distances between the Earth and the targeted planet. If a powerful engine and more advanced reactor are feasible, the round-trip time and fuel required can be significantly reduced. It is mainly illustrated that a 30 MW powered spacecraft can make the mission possible in five-year round trip constraint around year 2045. The trajectories obtained in the present study can provide an overall concept for the HOPE mission. The formulations in this paper can be also used to generate outbound and inbound trajectories for any round-trip interplanetary missions with VASIMR type propulsion system.

Development of Precision Attitude Determination System for KOMPSAT-2

Jae-Cheol Yoon[1], Dongseok Shin[2], Hungu Lee[2], Young-Ran Lee[2], Hyunjae Lee[3], Hyo-Choong Bang[3], Yee-Jin Cheon[1], Jae-Min Shin[1], Hong-Youl Moon[1], Sang-Ryool Lee[1], Gab-Ho Jeun[1]

[1]KOMPSAT Systems Engineering and Integration Department, Korea Aerospace Research Institute, Daejeon 305-333, Korea

E-mail: yjch@kari.re.kr

[2]Satrec Initiative Co. Ltd., Daejeon 305-811, Korea

[3]Korea Advanced Institute of Science and Technology, Daejeon 305-701, Korea

KARI precision attitude determination system has been developed for high accurate geo-coding of KOMPSAT-2 image. Sensor data from two star trackers and a IRU are used as measurement and dynamic data. Sensor data from star tracker are composed of QUEST and unit vector filter. Filter algorithms consists of extended Kalman filter, unscented Kalman filter, and least square batch filter. The type of sensor data and filter algorithm can be chosen by user options. Estimated parameters are Euler angle from J2000 frame to optical bench frame, gyro drift rate bias, gyro scale factor, misalignment angle of star tracker coordinate frame with respect to optical bench frame, and misalignment angle of gyro coordinate frame with respect to optical bench frame. In particular, ground control point data can be applied for estimating misalignment angle of star tracker coordinate frame. Through the simulation, KPADS is able to satisfy the KOMPSAT-2 mission requirement in which geo-location accuracy of image is 80 m (CE90) without ground control point.

Developnent of the KOMPSAT-2 Satellite Mission Control System

Byoung-Sun Lee, Sanguk Lee, Hee-Sook Mo, Sungki Cho, Won Chan Jung, Myungja Kim, In-Jun Kim, Tae-Hee Kim, Inone Joo, Yoola Hwang, and Jaehoon Kim

Satellite Ground Control Technology Team, ETRI

Daejeon 305-350, Korea

E-mail: lbs@etri.re.kr

KOMPSAT-2 satellite mission operations and control system has been developed by ETRI. The system functional architecture, analysis and design, implementation, and tests are presented in this paper.

A study on Initial conditions for Satellite Formation Flying using State Transition Matrix

Hyo-Joon Bang, Sang-Young Park and Kyu-Hong Choi
Department of Astronomy and Space Science
Yonsei University.

Traditionally in the two body problem, when we assume the circular orbit, Hill's equation has been used for describing relative motion. However, it is difficult to use Hill's equation in the case of the long period prediction because of the increasement of the errors caused by perturbations. To compensate this errors, we can use extended Hill's equation. An analytic solution considered the eccentricity and perturbations of chief satellite orbit can be used for the relative motion of formation-flying satellites. This strategy use a novel method called the geometric method using State Transition Matrix. The main goal of present study is to determine the initial conditions using the geometric method to maintain the feature of the formation flying accurately. To achieve the goal, we should find the State Transition Matrix for maintenance of the formation by considering the eccentricity and orbit perturbations. Then, we obtain the initial conditions to minimize the formation errors by analyzing the difference of orbital elements between a chief and a deputy satellite. At the last, the results are compared with those from traditional methods using numerical techniques. We analyze and discuss the characteristics of good initial conditions for satellite formation flying.

Development of Sun-Glint Prediction Program For The Communication, Ocean and Meteorological Satellite

Jae-Ik Park[1,2], Kyu-Hong Choi[1], Sang-Young Park[1], Byoung-Sun Lee[2] , and Yu-Hwan Ahn[3]

[1]Dept. of Astronomy and Space Science, Yonsei University.
[2]Electronics and Telecommunications Research Institute.
[3]Korea Ocean Research and Development Institute.

For helping the successful operation of the Communication, Ocean and Meteorological Satellite(COMS) which will be launched in 2008, algorithm to find precise locations of the sun-glint region on the ocean surface is developed. The precise locations of the sun-glint are estimated by considering Sun-satellite-earth geometry and the law of reflection. The derived nonlinear equations are solved using the Newton-Raphson method. Implementation of the Sun-glint prediction program was performed with C++, an Object Oriented Programing language, and FORTRAN language. Also Qt tool kit by Trolltech was used for implementing the graphical user interface. The validity of the algorithm developed has been demonstrated via STK software simulation. When the geostationary satellite is located at 116.2°E longitude, the sun-glint covers region of ±10° latitude and 80-150° longitude. The developed program algorithm in this paper can be applied to predict the precise locations of Sun-glint region in any other satellite.

Estimation of Solar Radiation Pressure on the Geostationary Satellite with a Single Solar Array Configuration

Gwanghyeok Ju, Youngwoong Park, Bang-Yeop Kim, Bong Kyu Park

COMS Program Office, Korea Aerospace Research Institute

In the geosynchronous orbit, the solar pressure is the primary source of environmental attitude disturbance on the geostationary satellite. The solar radiation pressure forces and torques are due to photons impinging on a surface in space. Computing the solar radiation pressure torque requires knowledge of the solar flux, the spacecraft orbit, and spacecraft geometry and surface properties. Meteorological satellites such as GOES I-M, GOES N-P, MTSAT, and COMS have three-axis, body-stabilized design capable of continuously pointing the optical line of sight of the imaging and/or sounding radiometers to the earth. Due to the thermal requirements of meteorological Imager, the satellite configuration requires that thereis only one solar array to avoid radiant temperature of objects on the radiant cooler facing the north (or south) side of the spacecraft. The use of a single-wing solar array mounted on the north (or south) panel of the spacecraft allows the passive south (or north)-facing radiation coolers of the imager and sounder to view cold space. However, the single solar array configuration induces a constant unbalance torque in inertial axes that required periodic wheels offloading. The wheel momentum accumulation is along the line orthogonal to the spacecraft-sun direction. In this paper, the solar radiation pressure on the geostationary spacecraft with a single solar array configuration is estimated at the long term and short term basis. In addition, the propellant amount which will be used for dumping of the accumulated momentum in the momentum/reaction wheel is also estimated. Simulations are performed based on worst-case parameters to evaluate the required frequency and durations of spacecraft maneuver.

Compelling Evidence Supporting The Boundary Layer Dynamics Model of Substorms

Gordon Rostoker
Department of Physics, University of Alberta

Over the past three decades, it has been customary to try to understand substorms by appealing to magnetic field line reconnection in the center of the magnetotail. Further discussion involves attempting to explain the substorm current wedge as the only manifestation of the substorm as detected by magnetometers in space and on the ground. In this talk I will present a view of the substorm as dominated by directly driven activity, with emphasis on the uniquely different aspects of substorm activity that appear on the poleward and equatorward branches of the double oval. I will support this view with data from an outstanding substorm event that will be difficult to explain in the context of any substorm model other than the boundary layer dynamics model (cf. Rostoker,G., Journal of Geophysical Research,101, 12,955, 1996).

Large-Scale Geomagnetic Disturbances Driven by Solar-Wind Discontinuities

L. R. Lyons[1], D.-Y. Lee[2]
[1]Dept. of Atmospheric Sciences, UCLA,
Los Angeles, CA, U.S.A.
[2]Dept. of Astronomy & Space Science, Chungbuk National University
Cheong-ju, Republic of Korea

Solar wind discontinuities can lead to important large-scale disturbances that significantly affect the space environment, including energetic particle fluxes, the aurora, and magnetospheric and ionospheric current systems. General correlations between solar wind parameters and overall geomagnetic activity are well known and well studied. However most large-scale disturbances are related to specific solar wind changes, and the relation of the resulting disturbance to solar-wind discontinuity characteristics has received much less attention. Two distinct types of discontinuity driven disturbance have now been identified: substorms resulting from northward interplanetary magnetic field (IMF) turnings and dynamic pressure (P) disturbances that result from enhancements of solar wind dynamic pressure. During typical substorms, enhanced auroral activity initiates near the equatorward boundary of the auroral oval within a ~1-2 hr MLT sector within the Harang electric-field reversal region and then expands to cover a few hours in MLT. Within the inner plasma sheet, particle injections and magnetic field dipolarization occur within what is referred to as the "substorm current wedge", which is within the same local time region as is the enhanced auroral activity. Typical P disturbances show rapid global enhancement of auroral emissions as well as a significant poleward motion of the poleward boundary of the aurora, but auroral enhancement related to the Harang reversal is not evident and substorm current wedge formation is not observed within the inner plasma sheet. We have recently found strong evidence that disturbances that occur following or during periods of strongly southward IMF are significantly different from typical disturbances. Under such conditions, substorms expand to a significantly broader MLT range than do typical substorms, and, in addition to a global auroral enhancement, P disturbances exhibit a substrom-like auroral enhancement within the Harang reversal that expands over a board MLT range. Thus for strongly southward IMF, both IMf and P changes can cause Harang region activation and current wedge formation. Because of this, it is reasonable to expect that IMF and P interplay effects may be important for solar

wind discontinuities having both a significant IMF change and a significant P change. Evidence will be presented that such interplay effects can indeed be important. In particular, discontinuities having a significant IMF northward turning and a significant decrease in P or having a significant increase in P and significant southward turning of the IMF are found to not lead to a substorm-like aurora disturbance within the Harang reversal region. We refer to such events as "null events", since the IMF northward turning or P increase for each would, by themselves, be expected to cause a large substorm disturbance, but the effects of these appear to be nullified by the simultaneous changes in the other quantity.

Characteristics of geosynchronous particle flux disturbances caused by the solar wind dynamic pressure enhancement

D.-Y. Lee[1] and L. R. Lyons[2]
[1]Dept. of Astronomy & Space Science, Chungbuk National University
[2]Dept. of Atmospheric Sciences, UCLA, Los Angeles, CA, U.S.A.

When a variation in the solar wind dynamic pressure hits the magnetosphere, various types of disturbances are created. The geosynchronous particle flux disturbance is closely related to the issues of magnetic storms, substorms, and sawtooth oscillations. In this work, using the LANL particle flux data, we have done an intensive examination on how the geosynchronous particle flux in the energy range of tens to hundreds of keV responds to a sudden increase in the solar wind dynamic pressure. We find significant differences in the flux response between different conditions of the accompanied IMF (interplanetary magnetic field). When the IMF remains northward at and prior to the time of the pressure increase, the most common type of the flux response we find is a simple dispersionless increase simultaneously at all availbale MLT positions. However we also find a significant number of events where the flux response is a decrease or virtually no notable change at all. Also, for this northward IMF condition, we find no notable differences in the flux response between protons and electrons. When the accompanied IMF is weakly southward, the flux response to the pressure increase is very similar to that in the case of the northward IMF. However, as the IMF becomes further southward, the flux response becomes more complex. When the IMF remains strongly southward at and prior to the pressure increase, we find a number of events where the flux change is characterized by a combination of global dispersionless increases (or decreases sometimes) and substorm-like injections. The substorm-like injection is often found to occur even near duskside (sometimes late afternoon) sectors. This is more easily seen in the change of proton flux. We will discuss how our result is different from typical substorm injections and and substorm injections under strongly south IMF condition.

KAO Space Weather Monitoring System: I. Overview

Kyung-Seok Cho[1], Yong-Jae Moon[1], So-Young Park[1], Hyungmin Park[1], Young-Deuk Park[1,4], Yeon-Han Kim[1], Roksoon Kim[1,2], and Jung-Eun Hwangbo[1,3]

[1]Korea Astronomy Observatory, Korea
[2]Dept. of Astronomy and Space Science, Chungnam National Univ., Korea
[3]Dept. of Astronomy and Space Science, Chungbuk National Univ., Korea
[4]Big Bear Solar Observatory, NJIT, USA

It is well known that solar activity such as Coronal Mass Ejections (CMEs) and flares cause the abrupt variations of space environment. Abrupt disturbance of space weather can result in serious effects on high technology systems as well as human. To efficiently predict the possible effects due to the disturbance, Space Weather Scales were introduced in 2000 by NOAA/SEC. The scales are divided into 3 types according to their sources and effects as follows: Radio Blackout (R), Solar Radiation storm (S), and Geomagnetic storm (G). Based on these scales, we have constructed the KAO space weather monitoring system by using ION (IDL on the Net). The monitoring system presents (1) realtime data such as x-ray flux, proton flux, and geomagnetic Kp index observed by GOES satellites; (2) the expected effects on communications and satellites automatically determined by the scales based on the realtime data; (3) 3-days forecast reports provided by NOAA/SEC; (4) propagation models that can be used to predict the arrival of interplanetary shocks and CMEs; (5) the mirror site of Active Region Monitor; and (6) web-based data base of several solar and geophysical activities. This presentation is an overview of the KAO space weather monitoring system under development, which is also well described in two poster papers. It is expected that the system can be used as a way of communication between general public and solar and space weather researchers.

Development of the Technology to locate and to observe Solar Bursts

Yong-Jae Moon, Kyung-Seok Cho, Young-Deuk Park,
Yeon-Han Kim, Jung-Eun Hwangbo, Su-Chan Bong
Korea Astronomy Observatory

The Korea Astronomy Observatory (KAO) started a five year project which includes (1) the development of solar radio burst locator (SRBL) and (2) the participation in the construction of 1.6 M New Solar Telescope (NST) at Big Bear Solar Observatory (BBSO), which is the largest aperture solar telescope in the world. This project will be made with the cooperation between KAO and New Jersey Institute of Technology (NJIT) in terms of science and technology. SRBL is expected to produce multi-band (1-18 GHz) solar microwave spectra and polarization with sub-second high time resolutions as well as to locate solar microwave bursts with an accuracy of less than 2 arcmin. Its data can be used as input data for interplanetary shock propagation models as a part of space weather prediction. Thanks to excellent seeing conditions of BBSO under NJIT and high order adaptive optics, NST will provide us with very fine spatial resolution (less than 0.1 arcsec) of solar optical and IR images as well as vector magnetograms to study the physical characteristics of very small scale structures such as magnetic flux tubes.

Interaction of the Magnetic Cloud and the Interplanetary Shock with Cosmic Rays

Su-Yeon Oh, Yu Yi
Dept. of Astronomy and Space Science, Chungnam National University

Forbush decrease (FD) is the event of Galactic Cosmic Ray (GCR) influx rate depression at least 3% within about a day. Previous studies on the solar wind modulator of FD revealed conflicting results. Drift hypothesis group suggested that FDs are caused by smoothly varying interplanetary magnetic field (IMF) in a magnetic tongues, whereas diffusion hypothesis group rather prefers the idea that diffusion is more significant in the turbulent IMF in the sheath region between the interplanetary shock (IPS) and the magnetic cloud (MC). We have selected the FD events with at least 5% flux depression and the MC and the IPS pairs observed in 1998 and 1999. We examined effectiveness of the IMF magnitude and turbulence on FD events. We would also present the preliminary application of this test to the solar cycle modulation of the GCR intensity.

Space Weather Studies at Kyushu University

Kiyohumi Yumoto
Space Environment Research Center, Kyushu University, Japan

In order to understanding couplings of the complexity and composite system, i.e. the solar wind-magnetosphere-ionosphere-Earth's surface system, the Space Environment Research Center (SERC), Kyushu University, Fukuoka, Japan will carry out coordinated ground-based network observations for space weather studies, in cooperation with about 30 organizations in the world during the international CAWSES (Climate And Weather of Sun-Earth System) period (2004-2008). Space weather is one of the four subjects of CAWSES program. SERC is now constructing a real-time MAGnetic Data Acquisition System for Circum-pan Pacific Magnetometer Network, i.e. MAGDAS/CPMN system. MAGDAS/CPMN has more than 50 magnetometers mainly along the meridian of Japan and along the magnetic equator. Starting this year, the magnetometer data will be sent to Kyushu University in a real-time manner via special lines for Internet, telephone lines, or satellite-phone lines. By using this system, we will conduct the real-time monitoring and modeling of (1) the global three-dimensional current system and (2) the plasma density variations in the geo-space for space weather researches and applications. The ordinary magnetic data can be used for studies of long-term variations, e.g. magnetic storm, auroral substorms, Sq, etc., while the induction-type magnetic data will be useful for studies of ULF waves, transient and impulsive phenomena. We also started 24-hr FM-CW Doppler radar observation at Sasaguri near our campus from September, 2003, to measure the ExB drift velocity in the ionospheric F region, to know the nature of global penetration of polar electric fields into the daytime equatorial region, and to investigate the relationships among the MAGDAS data along the 210 magnetic meridian, the ExB drift velocity in the low-latitude ionosphere, and the interplanetary magnetic and electric field variations. In the present paper, we will show preliminary results from the MAGDAS/CPMN and FM-CW Doppler observations.

Spacecraft observations of ULF waves

Kazue Takahashi
The Johns Hopkins University Applied Physics Laboratory, USA

Earth's magnetosphere exhibits a variety ULF of waves. Among these, the most powerful have periods in the range of 10-1000 s and they are known as Pc and Pi waves depending on whether their waveform is continuous or irregular. The period range corresponds to the MHD regime of the magnetospheric plasma, and in fact many properties of the observed ULF waves are successfully explained in terms of Alfven waves, fast waves, or the combination of the two. Historically, ground observations have played a major role in establishing various statistical properties of the waves. However, spacecraft observations provide crucial information regarding the mode and excitation mechanism of the waves. Both internal (magnetospheric) and external (solar wind) processes excite the ULF waves. An example of externally excited waves is the toroidal Alfven waves and an example of internally excited waves is Pi2 waves. We use recent spacecraft observations of these wave types to illustrate how spacecraft observations have contributed to our current understanding of MHD waves in the magnetosphere.

The Plasmasphere, and a Model for Plasmaspheric Density on 29 August 2000

Richard E. Denton[1] and Jerry Goldstein[2]
[1]Dept. of Physics & Astronomy, Dartmouth College, USA
[2]Space Sci. & Eng. Division, Southwest Research Institute, USA

The plasmasphere is a region surrounding the Earth with a relatively high density of ionized gas. The main ion constituent is hydrogen, but there are also significant populations of helium and oxygen. Embedded within the Earth's dipole magnetic field, the plasmasphere wraps around the Earth like a torus, typically within a distance of about four or five Earth radii from the center of the Earth. Until recently our only observations were from in situ measurements from single spacecraft, and it was unclear how structures observed by a spacecraft were connected to the plasmasphere. Since 2000, the Extreme Ultraviolet Imager (EUV) instrument on the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) spacecraft has been able to image the ultraviolet line emission of plasmaspheric helium, and this has led to many new insights about the global structure of the plasmasphere. The simplest picture describing the plasmasphere explains it as a region of closed convection paths circling the Earth. Here we describe the plasmasphere, explain why it exists, and how it typically evolves. Then we show how we develop a model for the global distribution of plasmaspheric density starting from an EUV image. The data from the image is supplemented with in situ electron density measurements and inferred mass density values based on oscillations of magnetospheric Alfven waves (these waves are oscillations of the Earth's magnetic field, which vibrates much like a guitar string).

Plasma Wave Coupling in Inhomogeneous Space: A New Approach

Dong-Hun Lee[1], Eun-Hwa Kim[1], Kyung-Sub Kim[1], Kihong Kim[2]
[1]Dept. of Astronomy & Space Science, Kyung Hee University
[2]Dept. of Molecular Science and Technology, Ajou University

Plasma waves in inhomogeneous space become complicated owing to existence of local cutoff and coupling as well as mode conversion. Previous theoretical methods such as the WKB and Bremmer approximations are invalid around the cutoff and singularities, where we can not obtain exact energy transport among the different wave modes. By adopting the concept of the invariant imbedding method, we have newly developed a powerful technique, which allows us to calculate the exact coefficients of reflection and transmission as well as the resonant absorption. We have derived a set of equations for fully coupled plasma waves in both unmagnetized and magnetized plasmas, which give correct results to the approximated solutions in previously published literature. We also introduce and discuss the time-dependent 3-D simulation results, which are compared with the theoretical approach.

The Predictability of the Magnetosphere and Space Weather

Xinlin Li
Laboratory for Atmospheric and Space Physics and
Department of Aerospace Engineering Sciences
University of Colorado at Boulder

Just how predictable is Earth's magnetosphere? With all the recent emphasis in the space physics community on 'space weather,' this has become an important practical question. The question is also fundamental to understanding the dynamics of the magnetosphere. For some years now there has been a mild controversy simmering between those who emphasize that the magnetosphere is mostly driven by the solar wind and thus its variability is due to the variability of the solar wind and those who emphasize that some of its variability is internally generated. Recent studies [Li et al., GRL, 2001; Temerin and Li, JGR, 2002] show that daily averaged radiation-belt electron fluxes at geosynchronous orbit and the Dst index, which measures the disturbance level of the Earth's magnetosphere, are predictable in a rather deterministic sense using solar wind as the only input. The accuracy of these predictions suggests that such large-scale magnetospheric features have a systematic response to the solar wind and chaotic behavior within the magnetosphere has little influence on the global outcome of such large features. In this presentation, I will focus on the Dst index: its derivation, measurements, and prediction.

Study on the Geosynchronous Relativistic Electron Events

Hee-Jeong Kim, Dae-Young Lee
Dept. of Astronomy & Space Science, Chungbuk National University

Relativistic electron fluxes in the outer radiation belt are highly dynamic, sometimes exhibiting events of the long-duration of high electron intensities. In this paper, we examine the characteristic solar wind dynamics and magnetospheric conditions associated with such relativistic electron event at the geosynchronous orbit. Statistical analysis of a number of solar wind and magnetospheric parameters shows that the occurrence of an event is accompanied by the prolonged solar quiet periods and thereby stable and more dipole-like magnetospheric configurations. For a typical relativistic event, the electron flux abruptly increases by orders of magnitude when the solar wind parameters drop to the low values (e.g., n_{sw} ~5 cm^{-3}, $|B_{IMF}|$ ~5 nT) after their sharp peaks. The elevated electron flux then stays at the high level during the prolonged solar quiet period. The occurrence of a geosynchronous relativistic event could be a matter of the balance between the effects of electron acceleration and loss. In addition, due to the strong dependence of the events on solar wind conditions, predicting the solar wind variations would be as important as understanding the electron acceleration mechanism(s) in the forecast of a relativistic event.

A case study to determine the relationship of relativistic electron events to substorm injections and ULF powers

Junga Hwang[1], Kyoung Wook Min[1], Ensang Lee[2], China Lee[1] and Dae Young Lee[3]

[1]Space Science Laboratory, Department of Physics, Korea Advanced Institute of Science and Technology, Daejon, Korea
[2]Space Sciences Laboratory, University of California, Berkeley, USA
[3]Dept. of Astronomy and Space Science, College of Natural Sciences and Institute for Basic Science Research, Chungbuk National University, Cheong-ju, Korea

We study the two storm events of 1997: one in May that was accompanied by a relativistic electron event (REE) and the other in September, with a more profound Dst decrease, but with no significant flux increase of relativistic electrons. We find that a larger amount of seed electrons was present in the May event compared to that of the September storm, whereas the ULF (ultra low frequency) power was more enhanced and the particle spectrum was harder in the September event. Hence, we demonstrate that a larger storm does not necessarily produce more seed electrons and that the amount of seed electrons is an important factor in an actual increase in REE flux levels, while ULF can harden the particle spectra without causing an apparent REE.

IGS: Services for Science and General Public

Peng Fang*
Scripps Orbit and Permanent Array Center
Scripps Institution of Oceanography
University of California San Diego, USA

International GPS Services is one of the most successful organizations in providing high standard and critical services for scientific community and general public for more than 10 years. This presentation will give an overview of the IGS infrastructure, its products, and generation of the products. Some forefront research areas and their prospective will also be covered.

* Participated IGS activities since IGS was funded 1993 and currently serve as an IGS governing board member.

Operational Orbit Determination Using GPS Navigation Data

Yoola Hwang, Byoung-Sun Lee, and Jae-Hoon Kim
Communication Satellite Research Group, Electronics and Telecommunications Research Institute, Daejeon, South Korea, 305-350

Operational orbit determination (OOD) depends on the capability of generating accurate prediction of spacecraft ephemeris in a short period. The predicted ephemeris is used in the operation such as instrument pointing and orbit maneuvers. In this study the orbit prediction problem consists of the estimating diverse arc length orbit using GPS navigation data, the predicted orbit for the next 48 hours, and the fitted 30-hour arc length orbits of double differenced GPS measurements for the predicted 48-hour period. For 24-hour orbit arc length, the predicted orbit difference from truth orbit was 205 meters due to the along-track error. The main error sources for the orbit prediction are solar pressure and atmosphere density for Low Earth Orbiter (LEO) satellite.

GPS based prediction of the Instantaneous Impact Point for KSLV-I

Sang-Wook Kang, Sang-Young Park, and Kyu-Hong Choi
CAST, Dept. of Astronomy and Space Science, Yonsei University

Korea has a plan to launch the satellite about 100kg weight into the low earth orbit using KSLV-I(Korea Space Launch Vehicle) which is three-stage liquid rocket in the some years. One of the most important things in launching vehicle is to ensure public safety during launch and flight. The instantaneous impact point(IIP) describes the touch down point of the launch vehicle under the assumption of an immediate termination of the boosted flight. A real time prediction of IIP is performed to monitor the expected impact position in case of flight termination. If necessary, we should terminate the flight of malfunctioning vehicles. Because IIP must be predicted in real time, it is necessary to use the rapid calculation algorithm. There are two methods commonly used. One method uses the Lambert theory assuming that flight trajectory is the Keplerian orbit. The other method uses the linearized model which is a simple parabolic trajectory assuming the flat earth. For this method, various corrections can be adopted to account for the curvature of the surface of the earth as well as the integral effects of the Coriolis force and gravity field changes along the trajectory. For the prediction of IIP, it is necessary to know the real time position, and velocity informations of launch vehicle. After obtaining flight informations of KSLV-I from numerical simulations of six degrees of freedom equations of motion, we predict the instantaneous impact point of KSLV-I using the two methods mentioned above. The precision of instantaneous impact point depends on the quality of real time information for the position, and velocity of the vehicle. Flight information observed by radars usually includes large errors while flight information observed by the GPS receiver includes relative small errors. Hence, we can predict more accurate IIP and reduce the cost, when GPS receiver is used to obtain the flight information. For the studies, it is assumed that the flight informations of KSLV-I through both the radars and GPS receivers are obtained. With the fictitious flight data, we can compute the IIP by using the two methods. We analyze the advantages and disadvantages of each IIP prediction method.

LEO satellite orbit maneuvers for increasing resolution of space image

Hyung-Mo Oh, Sang-Young Park, Kyu-Hong Choi
Center for Astrodynamics and Space Technology
Dep. Astronomy and Space Science Yonsei University.

In modern days, the importance of satellite for the military reconnaissance and mapping has been increased. Specifically, today's wars have proved that the image by the military reconnaissance satellite is one of the crucial and determinant factors for the intelligence support. This study presents an optimal orbital descending method for improved image resolution of LEO satellites. Using the Lambert's theorem, satellite is transferred from 500~1,500km to 200km. Comparing the required velocities(ΔV) for the orbit maneuvers, optimal orbital transfer strategy is obtained, and the rates of fuel consumption applied are calculated. The results can be used for the determination of the satellite capabilities for the military reconnaissance missions by comparing the results from the STK Tool and those from present study, the accuracy of the result obtained is examined. For the future work, the studies on the non-coplanar orbital transfer should be executed. These studies may be efficiently used for mission designs and the operations of the military reconnaissance satellites.

Covariance Analysis of Two Spacecraft System Using Relative Line of Sight Vector Measurements

Jo Ryeong Yim, Yong-Bok Kim, and Seung-Wu Rhee
Satellite Control System Department, Korea Aerospace Research Institute, Daejeon, 305-333, Republic of Korea

Autonomous orbit navigation of a pair of Earth-orbiting system is considered with the relative line-of-sight vector measurements between two spacecraft system. Numerical observability analysis of the system with the available measurements using the linear observability analysis and the relative state variable observability were presented in the Spring Conference, 2004. In this presentation, analytical observability analysis is dealt with the same relative line-of-sight vector measurements. Furthermore, covariance analysis based on the batch filter is investigated with the various orbit configuration, and with a representative case, another covariance analysis based on the extended Kalman filter is considered in order to infer the filter performance with solely the initial state error and the measurement error using the relative line of sight measurements. For measurement frequency, the final time covariance error and the mean covariance error show that the more frequent measurement update gives the state estimate more accuracy. For measurement accuracy, the estimation accuracy directly depends almost linearly on the accuracy of the relative LOS vector measurements. The covariance errors at final time show that the position can be determined with an accuracy of about 50 m and the velocity about 1 m/sec.

Formation Trajectory-Planning using Nonlinear Programming and Collocation

Hyung-chul Lim[1,2], Hyochoong Bang[2], Pil-ho Park[1] and Jong-uk Park[1]

[1]GPS Research Group, Korea Astronomy Observatory
[2]Dept. of Aerospace Engineering, KAIST

Satellite formation flying has become a topic of significant interest in the aerospace engineering because its system has several benefits compared to a large spacecraft. Some techniques have been presented to get optimal formation trajectories minimizing fuel consumption in the step of configuration or reconfiguration. In this study, a method is introduced to find fuel-optimal trajectories minimizing cost function that includes the total fuel consumption of all satellites and assignment of fuel consumption rate for each satellite. This method is based on collocation and nonlinear programming which subjects to constraints for collision avoidance and final configuration. New constraints of nonlinear equality or inequality are derived for final configuration and nonlinear inequality constraints are used for collision avoidance. The final configuration constraints are that three or more satellites should form a projected circular orbit and make an equilateral polygon in the horizontal plane. Some problems, including these constraints and the cost function, are simulated using the method to generate optimal trajectories for configuration and reconfiguration of a satellite formation.

Determination of Tropospheric Slant Wet Delay Using GPS

Jihyun Ha[1,2], Kwan-Dong Park[3], Pil-Ho Park[1] and Jong-Uk Park[1]
[1]GPS Research Group, Korea Astronomy Observatory
[2]Dept. of Astronomy and Space Science, Chungbuk National University
[3]Dept. of Forest Resource, Kookmin University

The GPS(Global Positioning System) satellite signals get delayed due to the water vapor in the atmosphere before reaching the GPS receiver on the ground, thus causing positioning errors. Thus, one can compute the amount of the water vapor by processing the GPS data and translate it into Precipitable Water Vapor (PWV), which can be assimilated into Numerical Weather Prediction. Especially, 3-dimensional distribution of the water vapor is an important factor to determine for accurate weather prediction and climate studies. Slant Wet Delay (SWD), the amount of the GPS signal delay along the line of sight between a GPS receiver and the satellite, should be precisely calculated to create 3-D distribution map of the water vapor. In this study, we used a Canadian permanent GPS site to estimate the SWDs and compared the estimates with co-located Water Vapor Radiometer (WVR) measurements. To improve the accuracy in GPS data processing, three major error sources were considered: azimuthal variations in the wet mapping function, ocean loading displacements, and GPS antenna phase center variations.

Station-Keeping Maneuver Simulation for the communication Ocean and Meteorological Satellite

Young-Rok Kim[1], Byoung-Sun Lee[2], Hyo-Joon Bang[1], Kyu-Hong Choi[1], Sang-Young Park[1]

[1]Dept. of Astronomy and Space Science, Yonsei University, Seoul, 120-179, Korea

[2]Satellite Ground Control Technology Team, ETRI, Daejeon, 305-350, Korea

E-mail: puresunrise@galaxy.yonsei.ac.kr

Automated east/west and north/south station-keeping maneuvers were simulated for the geostationary COMS(Communication, Ocean and Meteorological Satellite) satellite that will be launched around year 2008. The satellite has to be maintained within ±0.05° at the nominal longitude of 128.2°E. The general perturbation method was used to keep the position of the geostationary satellite. Weekly based east/west and biweekly based north/south station-keeping maneuvers were investigated. The sun-pointing perigee control method and two-burn strategy were used for the east/west station-keeping maneuver. Switching the right ascension of the ascending node to descending node was adopted for the north/south station-keeping maneuver. One year station-keeping maneuver was demonstrated and various station-keeping orbital parameters were analyzed.

A Reduced Dimensional Gimbal Rate Steering Law for Singularity-Free Control

Bong-Un Lee[1], Do-Hyeon Kim[1], So-Jung Kim[1]
Hwa-Suk Oh[2]
[1]Graduated Student, [2]Associate Professor
School of Aerospace and Mechanical Engineering
Hankuk Aviation University, Koyang, 412-791, Korea

In using single-gimbal control moment gyros (SGCMGs) for spacecraft attitude control, geometric singularity problem is one of the principal difficulties. The steering laws to avoid singular conditions have been extensively studied, however, those steering laws are not fully satisfying to avoid singularity problem. A new steering logic is suggested in this paper, which results in reducing the difficulties in generating gimbal rate steering law around singularities. By adopting the singular value decomposition (SVD) in reduced dimensional forms, the steering law is generated in a series of rate steering laws. The insufficiency in generated torque has been compensated by a successive calculation of steering laws. To verify the performance of this logic, simulations are implemented at several singular conditions and compared with other singularity avoidance laws, such as singularity robustness steering law and singular direction avoidance steering law.

Dynamic Compensation in Measurments and Identification of Reaction Wheel Disturbance Model

Hwa-Suk Oh[1], Dong-Ik Cheon[2], Shin-Hoo Choi[2]
[1]Associate Professor, [2]Graduated Student
School of Aerospace and Mechanical Engineering
Hankuk Aviation University, Koyang, 412-791, Korea

The disturbance torque and force produced by reaction wheel, an actuator for satellite attitude control, have an influence on the pointing stability of high precision satellite and make a measurement of disturbances necessary for such a satellite. The measurement table equipped with several loadcells is usually used as one of the favorite types of measurement devices. The disturbance, however, stimulates the elasticity of the loadcells and inducesthe vibration of the table. This then causes the measurement error, which is especially large near the resonance frequencies of the table. In order to reduce this type of error, a calibration process with frequency compensation is suggested in this paper. The disturbance power spectrum is calibrated by the dynamic frequency compensation process, from which the precision model of disturbance can be obtained. Since the degradation of data accuracy caused by the table vibration is well alleviated even in the resonance area, the measurement range can be expanded up to the frequency area including the resonance frequencies. The measurement and compensation method is verified through the experiments for HAU reaction wheel, the development model for STSAT-1. The compensation method has been adopted for the HAU measurement table where three uni-directional loadcells are used.

Design and Implementation of On-Board Computers For STSAT-2

Changwan Ryu[1], Myungjin Choi[1], Daesoo Oh[1],
Kyungin Kang[1], Myeong-Ryong Nam[1], Junghoon Keum[2]
[1]Satellite Technology Research Center, KAIST, Daejeon, 305-701, Korea
[2]Korea Aerospace Research Institute(KARI), Daejeon, 305-333, Korea
E-mail: cwryu:prime:jjasu:kikang:nam@satrec.kaist.ac.kr

The Engineering Model of on-board computer was developed and tested completely with other sub-systems for STSAT-2. We designed the on-board computer of STSAT-2 which has some improved features compared with that of STSAT-1. A remarkable change is that the on-board computer has a structure of centeralized network communication without a Network Controller of the STSAT-1. That is, the on-board computer directly manages a satellite network. In addition, as many logics are implemented by Field Programmable Gate Array, so we can reduce the weight and size of on-board computer. Also, the developed on-board computer has more improved tolerance against Single Event Upsets and faults than that of the STSAT-1.

Calibration and Error Analysis of Performance Test Equipments for Sun Sensor

Shi-HWan Oh, Yong-Bok Kim, Seung-Hoon Lee,
Jo Ryeong Yim, Hong-Taek Choi and Seung-Wu Rhee
Satellite Control System Dept., Satellite Technology Division,
Korea Aerospace Research Institute

In order to measure the accuracy of sun sensor, a performance test equipment which consists of solar simulator, 3-axis rotary table and auto-collimator is needed and should be calibrated to get a reliable and more accurate data. Solar simulator should be aligned with rotary table as parallel as possible and the measurement error and resolution for rotary table after a specific 3-directional rotation should be analyzed and calibrated. We briefly introduce the calibration result of the equipment for sun sensor performance test in the paper. Also, we measured the internal misalignment of sun sensor with the rotary table alignment method. Finally the accuracy of sun sensor under 1 AMO sun light was calculated from the measured data.

Research of Proton Irradiation Effect by Ground Based MC-50 Cyclotron for Spacecraft's Shielding of Polyimide Kapton

Dae-Weon Kim[1], Dong-Iel Kim[2], Yong-Hak Huh[2], Tae-Keun Yang[3] and Yong-Hyup Kim[1]

[1]School of Mechanical & Aerospace Engineering, Seoul National University

[2]Center for Environment and Safety Measurement, KRISS, Daejeon

[3]Laboratory of Cyclotron Application, KIRMS, Seoul

Space environment effects on polyimide Kapton® is studied for more effective operation of spacecrafts. Polyimide Kapton® is widely used for spacecrafts including satellites for the long duration of space mission. Kapton® shows the best performance for the thermal control and protection against the strong ultra-violet irradiation among the various organic and synthetic materials. Tensile stress of Kapton® film is measured by using self-designed Micro Tester in KRISS(Korea Research Institute of Standards and Science). ITO(Indium Tin Oxide) sputtered and aluminized back Kapton H® is exposed to proton irradiation of 27 MeV energy through MC-50 cyclotron at KIRMS(Korea Institute of Radiological & Medical Sciences) for 5, 15, 25, and 50 minutes, which are equivalent to 1, 3, 5, and 10 years exposure time in space, respectively. For 1 and 3 year specimen, the tensile strength becomes higher than untreated material due to the surface enhancement by ion beam effect. For 5 and 10 year specimen, the tensile strength gradually becomes lower than untreated material due to crystalline damage. Therefore, it can be inferred that the mechanical property of Kapton® degrades after 5 year operation by solar proton irradiation in space.

Development of A Photogrammetry System for Use under Thermal Vacuum Environment

Sang-Hoon Lee, Hyokjin Cho, Hee-Jun Seo, Chang-Wuk Woo, Guee-Won Moon and Seok-Weon Choi
Space Test Div. Korea Aerospace Research Institute

The study of shape deformation in a large spacecraft such as the antenna of communication satellites and large space reflectors is essential in the design of the satellite system. A photogrammetry system can accurately measure the structural deformation of these space objects under the space environment. Photogrammetry, as its name implies, is a 3-dimensional coordinate measuring technique that uses photographs as the fundamental medium for metrology. In the last few years, the accuracy of photogrammetry has increased dramatically through the rapid advance of digital camera. The SITC(Satellite Integration & Test Center) at KARI in KOREA is equipped with a series of space environmental test facilities as like the thermal vacuum chamber. Lately manufacturing of the Large Thermal Vacuum Chamber(LTVC) with useful dimension of Φ8m×L10m is well advanced. The purpose of this study is to confirm the possibility in order to perform thermal distortion measurements of the antenna in the LTVC and to apply the result to the chamber design.

Thermal System Design for a Large Space Simulator(Φ8m x L10m)

Guee-Won Moon, Chang-Lae Cho, Hyokjin Cho, Sang-Hoon Lee, Hee-Jun Seo, and Seok-Weon Choi

Space Test Div., Korea Aerospace Research Institute

According to the National Space Program of Korea, KARI(Korea Aerospace Research Institute) has been developing a large space simulator (working dimension; Φ8m x L10m) to verify the performance of future large satellites under the space environment conditions. Especially, a very low temperature condition of space will be simulated by shrouds covering the inside surface of the vessel. The surface of shrouds will be cooled down to 77K by liquid nitrogen(LN2) from ambient temperature and hence, an optimal LN2 circulation system design is necessary to remove gaseous nitrogen(GN2) sufficiently and maintain the shrouds at the LN2 temperature.

Evaluation of the Measurement Noise and the Systematic Errors for the KOMPSAT-1 GPS Navigation Solutions

Hae-Dong Kim, Eun-Kyou Kim and Hae-Jin Choi
Satellite Mission Operation Department, Korea Aerospace Research Institute

GPS Navigation Solutions are used for operational orbit determination for the KOMPSAT-1 spacecraft. GPS point position data are definitely affected by systematic errors as well as noise. Indeed, the systematic error effects tend to be longer term since the GPS spacecrafts have periods of 12 hours. And then, the overlap method of determining orbit accuracy is always optimistic because of the presence of systematic errors with longer term effects. In this paper, we investigated the measurement noise and the system error for the KOMPSAT-1 GPS Navigation Solutions. To assess orbit accuracy with this type of data, we use longer data arcs such as 5-7 days instead of 30 hour data arc. For this assessment, we should require much more attention to drag and solar radiation drag parameters or even general acceleration parameters in order to assess orbit accuracy with longer data arcs. Thus, the effects of the consideration of the drag, solar radiation drag, and general acceleration parameters were also investigated.

Korea Astronaut Mission Proposal with Analyzing Astronaut Missions of European Space Agency

Youn Kyu Kim, Jong-Woo Kim, Joo-Hee Lee, Gi-Hyuk Choi
Satellite Mission Operation Department, Satellite Operation & Application Center, KARI, 45, Oun-dong, Daejeon, 305-333, Korea
305-701, Korea
E-mail: ykkim@kari.re.kr

It is no exaggeration to say that science and technology of Korea stand shoulder to shoulder with the developed nations at present. So it is thought space development ability of Korea with such infrastructures is enough and there has been deep concern and many investment about the development of a launch vehicle, stellite, and so on. It is time to need to cultivate a Korea astronaut as to promote the growth of technology with more international competitiveness when we consider such space development ability and technical level of Korea, that is, to make a chance to join the ranks of advanced countries of a space industry through which a Korea astronaut is cultivated, visits International Space Station (ISS), grasps environment about space and does experiments about a long term stay of human. This not only make science and technology ability growed but make interest of a people about science and technology raised, in particular this have many merits in the side of education to students. This paper is studied about missions which a Korea astronaut carries out when a Korea astronaut is first cultivated. First of all, scientific missions which astronauts of EAS(European Space Agency) similar to conditions and a method of Korea Astronaut cultivation experiment on the ISS (International Space Station) in space are studied. European astronauts are one of the outcomes of a framework agreement signed between ESA and Russia in May 2001, allowing European astronaut to fly to the ISS on Russian launchers during the period 2001 to 2006. After that, missions suited to a Korea astronaut are proposed and inspected. The proposed missions are largely categorized with six fields, that is biology, physiology, physical science, earth observation, technology and education. Biology experiments mainly aim to study the effect of space environment, weightlessness and radiation, on a gene, metabolism and structure of life cell using bacteria, plants, fly, and so on. Physiology experiments mostly consist of physical and mental examinations. This study aim at the long term stay of a human. The physical science study suggests experimenting a physical phenomenon to arise just

in space. This study in earth observation suggests observing the earth from the ISS using digital microcamera. In technology, this mainly proposes facilities the inside of the ISS and experimental equipments. In education, this activity is to provide the information of a spaceship life and space environment with plants and experimental device, to demonstrate a physical phenomenon to students with a educational objectivity. Experimenting in spaceship has so many problems relative to safety, a limit of time and room, restriction of experimental equipments and especially experience shortage of a Korea astronaut. So it is thought that significant and many experiments are impossible. But if this approach in the long run, space programs can achieve more growth.

The Selection Criteria of Korean Astronauts

Joo-Hee Lee[1], Gi-Hyuk Choi[1], Youn-Kyu Kim[1], Jong-Woo Kim[1], Won-Kuen Lee[2] and Sang-Ho Hwang[3]

[1](Korean Astronaut Office), Satellite Operation & Application Center, Korea Aerospace Research Institute

[2]Aerospace Medical Safety Research Institute, Hanseo University

[3]Aero-medical Center, Republic of Korea Air Force

Ministry of Science & Technology(MOST) and Korea Aerospace Research Institute(KARI) are preparing for the first Korean Astronaut Program based on the mid and long-term basic plan for space development of Korea from the year of 2002. Major aspects taken into consideration are psychological suitability, scientific and technical competence, linguistic ability and fulfillment of medical criteria.

Astronauts must be in good physical and psychological condition. Perfect vision and hearing are not required, but an astronaut's body needs to be strong and physically fit. The stress of g-forces during liftoff and reentry takes a toll on the body, as does the effect of prolonged weightlessness. For these reasons, it can be an unpleasant and dangerous experience for anyone not in top physical condition.

Astronauts need to be hard workers. And getting in to space involves a tremendous amount of preparation. Many physical skills, such as moving about in a space suit, need to be learned. Many technical skills, such as operating the experiment equipments in the manned spacecraft or space station, need to be mastered.

The first Korean astronaut selection is based on the following criteria:

● General Suitability

The general suitability decision process for Korean astronauts involves an assessment of the candidate's past and present conduction in order to predict probable future actions that may adversely impact a space flight. The following list defines some of the factors that would be considered as a basis of disqualification:

(a) delinquency or misconduct in prior employment/military service;
(b) criminal, dishonest, infamous, or notoriously disgraceful conduct;
(c) intentional false statement or fraud in examination or appointment;
(d) habitual use of intoxicating beverages to excess;
(e) abuse of narcotics, drugs, or other controlled substances;

(f) membership or sponsorship in organizations which adversely affect the confidence of the public in the integrity of, or reflecting unfavorably in a public forum on, any Space Program Partner or Cooperating Agency.

For Korean astronauts, general suitability is determined in the first stage of selection with another background review.

● Medical Suitability

The candidate must meet the agreed-upon medical criteria as established by the Korean astronaut program medical board for space flight. This includes the medical aspects of behavioral assessments.

● Behavioral Suitability

Korean astronaut program board, in accordance with the internal procedures, will determine if candidate has the interpersonal and communication skills necessary to function as a successful member of a space flight team in a multicultural environment and has the ability to demonstrate situational awareness to conduct himself or herself effectively in the space environment.

● Linguistic Ability

Oral and reading fluency in the English language is a requirement for all candidates. In addition, the ability to communicate effectively in other languages may be required. Candidates must possess both the capacity and the interest to learn a foreign language.

If most of these qualities describe you, then you may have qualification to become a first Korean astronaut someday. Then you can begin your training at the Yuri Gagarin Cosmonaut Training Center in Star City, Russia.

Eclipsing Binaries, The primary Distance Indicator

Young Woon Kang[1], Kyeong-Soo Hong[1]
Ho-il Kim[2], Woo-Baik Lee[2]
[1]Dept. of Astronomy and Space Science & Astrophysical Research Center for the Structure and Evolution of the Cosmos
Sejong University
[2]Korea Astronomy Observatory

The distances to the local group galaxies can be estimated by Cepheids, W Virginis, and RR Lyrae variables. Beyond this the distances to extra galaxies are determined by the various methods including globular-cluster luminosity functions, novae, supernovae type-Ia, Tully-Fisher relations, planetary nebular luminosity functions, surface brightness functions, and fundamental-plane relationships for elliptical galaxies. The Cepheid variable has been used as the primary distance indicator. This first calibration step to set zero point is very important and is a current subject of intense research. Thus we tested possibility that eclipsing binary stars can be used as the primary distance indicator which serve to set zero point.

A total of 334 eclipsing binaries listed in catalogue of A Pictorial Atlas (Terrell et al. 2001) was analyzed for the distance of each binary system. First absolute dimension of each binary system was deduced from relative radii and semi-major axis, then absolute magnitude of the binary system were reduced. For the apparent magnitudes of the systems we used the maximum magnitudes in the SIMBAD database. After extinction correction of the apparent magnitude we find distances of the binary systems and compared with those of the Hipparcus.

Star Formation in the Large Magellanic Cloud

Sungeun Kim

Dept. of Astronomy and Space Sciences & Astrophysical Research Center for the Structure and Evolution of the Cosmos, Sejong University

We present Antarctic Submillimeter Telescope and Remote Observatory (AST/RO) observations of CO J=4-3 and CO J=7-6 emission in the 30 Doradus complex in the Large Magellanic Cloud. We detected strong CO J=4-3 emission toward R140, a multiple system of Wolf-Rayet stars located on the rim of the fast-expanding HII shell surrounding the R136 cluster. We report the possible detection of the CO J=7-6 emission in the LMC towards the north of R139 in the giant HII region complex 30 Doradus. We also detected high-velocity gas component as a separate in the CO J=4-3 spectrum. This probably originates from molecular material accelerated as a result of the combined motion induced by the stellar winds and supernovae explosions including several fast-expanding HII shells in the complex. The lower limit of the total kinetic energy of the atomic and molecular gas component is about $2x10^{51}$ergs, suggesting that this is only 20% of the total kinetic energy contained in the HII complex structure.

CCD PHOTOMETRY USING MULTIPLE COMPARISON STARS
Distance and accreton luminosity of the long-period eclipsing polar V1309Ori

Yonggi Kim[1], Ivan L. Andronov[2,3,1], Young-Beom Jeon[4]

[1]Dept. of Astronomy and Space Sciences, Chungbuk National University, Korea
[2]Department of Astronomy, Odessa National University, T. G. Shevchenko park, UA 65014, Odessa, Ukraine
[3]Crimean Astrophysical Observatory, UA 98409 Nauchny, Ukraine
[4]Korea Astronomy Observatory, Daejeon 305-348, Korea

The accuracy of CCD observations obtained at the Korean 1.8 m telescope has been studied. Seventeen comparison stars in the vicinity of the cataclysmic variable BG CMi have been measured. The "artificial" star has been used instead of the ``control" star, what made possible to increase accuracy estimates by a factor of 1.3-2.1 times for "good" and "cloudy" nights, respectively. The algorithm of iterative determination of accuracy and weights of few comparison stars contributing to the artificial star, has been presented. The accuracy estimates for 13-mag stars are around 0.002 mag for exposure times of 30 sec.

Simulations of the photospheric convection in subgiant stars

Y. -C.Kim[1], F. J. Robinson[2], K. L. Chan[3]
and P. Demarque[2]

[1]ISST and Dept. of Astronomy, Yonsei University
[2]Dept. of Astronomy, Yale University
[3]Dept. of Mathematics, HKUST

In this poster we will describe results of our 3D large eddy simulations of stellar surface convection using realistic model physics. The simulations include the present Sun, a sub-giant of one solar mass, and a lower gravity subgiant, also of one solar mass. We examined the thermal structure (superadiabaticity) after modification by 3D turbulence, the overshoot of convective motions into the radiative atmosphere, and the range of convection cell sizes. Differences between models based on the MLT and the simulations, were found to increase significantly in the more evolved stages as the surface gravity decreases.

FIMS Observations of The Monogem Ring

Il-Joong Kim[1,2], K.-I. Seon[2], K.-W. Min[1], K.-S. Ryu[1], D.-H. Lee[2], W. Han[2], W.-W. Nam[2], I.-S. Yuk[2], J.-H. Park[2], H. Jin[2], J. Edelstein[3], E. Korpela[3], and K. Nishikida[3]

[1]Korea Advanced Institute of Science and Technology
[2]Korea Astronomy Observatory
[3]Space Sciences Laboratory, University of California, Berkeley

We present far ultraviolet emission spectra and maps of the "Monogem Ring", observed with FIMS(also known as SPEAR) onboard the first Korean scientific satellite STSAT-1. We anticipate that the Monogem Ring is a fragmented, shell-like structure in the FUV bands as in X-ray observation. O Ⅵ(~1035Å), C Ⅳ(~1555Å) emission lines and spatial emission variations within the ring are studied.

Absolute Parameters of a eclipsing binary AG Virginis

Ho-Il Kim, Chung-wook Lee, Jae-Woo Lee
Korea Astronomy Observatory

A double-lined radial velocity curve and BVR light curves of a eclipsing binary AG Vir were made using BOES at BOAO and 2k CCD camera at SOAO during a observing season in 2004. Our new radial velocity curve shows no significant differences with previous one but has more data points spreaded over the entire phase. Light curves show large scatter because the comparison star is much fainter and, however, show certain difference in brightness between two maxima at $0^P.25$ and $0^P.75$ which is known as O'Connell effect. The radial velocity and light curves were implemented simultaneously to WD code to calculate the spectroscopic and photometric parameters of AG Vir and we found that this binary is in a marginal contact or contact Loche configuration and has a spot on the secondary component. Mass and radius of each component in solar unit were estimated.

The effects of α-element enhancement on isochrones; A detailed analysis

Song Eui Park, Yong -Cheol Kim
Dept. of Astronomy, Yonsei University

Globular clusters are the most useful celestial objects in age estimation of the universe. Such calculations are possible through comparison of observed CMDs with theoretical isochrones. An isochrone is the locus of different masses with same age. The shape of an isochrone depends on several parameters, that is, mass, age, [Fe/H], mixing length and α-elements enhancement. The effects of α-element enhancement on different parts of an isochrone will be explored in detail. In the process, the limitation of Salaris formula, mimicked α-element enhancement with [Fe/H], will be explored and an alternative formula be suggested.

CO to H_2 ratio of interstellar molecular cloud

Jae-Woo Park[1], Dae-hee Lee[2], Kyoung-Wook Min[1]
[1]Department of physics, Korea Advanced Institute of Science and Technology
[2]Korea Astronomy Observatory

Far ultraviolet spectrum enables us to know about the composition and character of interstellar medium. Berkeley Extreme and Far ultraviolet Spectrometer (BEFS) of the ORFEUS satellite and Far Ultraviolet Spectroscopic Explorer (FUSE) are the most common detector in the region of FUV. PDR is a Photo-Dissociation Region that interacts with nearby bright stars. Observation of this region has revealed many facts especially about the diffuse clouds. We select 7 stars consist of only one component molecular cloud among 56 stars detected by BEFS. In the direction of sight, these clouds exist in front of the star. We select a CO absorption line E-X (0-0) band at 1076Å, which has a large oscillator strength and is not blended with other interstellar absorption lines. From equivalent width of this line we can calculate a CO column density, and get a direct CO to H_2 ratio in the three regions. (HD37903, HD164794, HD214080)

Low Mass Ratio Contact Binary V410 Aur and V776 Cas

Kyu-Dong Oh[1], Chun-Hwey Kim[2], Ho-Il Kim[3], Woo-Baik Lee[3]

[1]Chonnam National Universiry, [2]Chungbuk National University, [3]KAO

We present the first BVR CCD full light curves of low mass ratio contact binary V410 Aur and V776 Cas. The CCD photometric observations were obtained at Soback Mt. Observatory with 61 cm Cassegrian reflector from September 2003 to February 2004. The absolute dimensions of V410 Aur and V776 cas were obtained by using WD code from the published spectroscopic and our photometric observations. The evolutionary status of the low mass ratio contact binary system including V410 Aur and V776 Cas has been considered.

Chemical Enrichment and Star Formation Histories of the Sextans Dwarf Spheroidal Galaxy

In-Soo Yuk[1], Myung Goon Lee[2]
[1]Korea Astronomy Observatory
[2]Astronomy Program, SEES, Seoul National University

We present a study of chemical enrichment and star formation histories of the Sextans dwarf spheroidal galaxy (dSph) in the Local Group. For this aim, we have developed a code which calculates chemical evolution of galaxy and generates synthetic colour-magnitude diagram (CMD) from theoretical stellar evolution models. By incorporating chemical evolution models with methods of finding star formation history, we solve age-metallicty degeneracy problem. Comparisons between the chemical evolution models and the observed abundance patterns will be shown.

Observation of molecular hydrogen fluorescence in the Taurus region by FIMS

Dae-Hee Lee[1], Ho Jin[1], Uk-Won Nam[1], Wonyong Han[1]
Kwang-Sun Ryu[2], Jong-Ho Shinn[3], Kyoung-Wook Min[3]
Jerry Edelstein[4], Kaori Nishikida[4], Eric Korpela[4]
[1]Korea Astronomy Observatory
[2]Satellite Technology Research Center, KAIST
[3]Department of Physics, KAIST
[4]Space Science Lab.,UCB

We observed molecular hydrogen fluorescence emitted in the Taurus region by FIMS. FIMS is a far-ultraviolet spectrograph optimized for observing FUV diffuse emission lines in the ISM. The image of H2 fluorescence shows that the physical process of fluorescence is undergoing in the outer shell of the Taurus cloud.

A new pre-data reduction program for the array On-The-Fly observations

Myung-Hyun Rhee[1], Hyoryoung Kim[2], Eun-Jung Jung[3]
[1]Yonsei University Observatory, Yonsei University
[2]TRAO, Korea Astronomy Observatory
[3]Department of Astronomy, Yonsei University

We developed a new pre-data reduction program which could save large amount of telescope time and improve final map quality considerably for the array On-The-Fly (OTF) observations. We present preliminary results from the analysis of the CO OTF data for the Virgo spirals obtained with the Five College Radio Astronomy Observatory (FCRAO) 14m telescope. We also discuss the usefulness of the method for future array On-The-Fly (OTF) observations.

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Dynamical Substructures of Galactic Globular Clusters

Jongwhan Rhee and Young-Jong Sohn
Center for Space Astrophysics and Department of Astronomy,
Yonsei University, Seoul 120-749, Korea
E-mail : jhrhee@galaxy.yonsei.ac.kr, sohnyj@csa.yonsei.ac.kr

We used BV CCD images to study the dynamical substructures of three globular clusters - M5, NGC6934, NGC7006 - analyzing the radial variations of ellipticity and position angle from the point spread function stellar photometry and the ellipse surface photometry. Several populations were classified by the brightness on color-magnitude diagrams of each globular cluster. Ellipse analyses to the images, removed stars of each population from the original images of the clusters, show radial variations in ellipticity and position angle, with the amount of 0.01~0.25 in ellipticity and +90~-90 degrees in position angle up to roughly three times of half light radius (r_h). It is also apparent that there are no significant discrepancies in the dynamical substructures beyond r_h among the different populations. However, dynamical substructures on the central region (i.e., inner than ~r_h) reflect the contributions of populations of bright red giant stars and horizontal branch stars.

The spectral analysis of the dayglow limb scanning data of FIMS in STSAT1

Chi-Na Lee,[1] Kyung-Wook Min,[1] Kyang-Sun Ryu[2]
[1]Dept. of Physics in KAIST
[2]SaTReC(Satellite Technology Research Center)

Far-Ultraviolet Imaging Spectrograph(FIMS) on the STSAT-1 satellite launched in 2003 observes the space in astronomy and space physics area with the two spectral band. One is the long wavelength band, 1350-1730Å(L-band), the other is the short band, 880-1160Å(S-band), in FUV. FIMS performed the dayglow observations about three different events at August, 2004. The satellite surveyed the dayglow region in the method of limb scanning. Detector measured the electron counts through the S-band. Dayglow spectra in atmosphere mostly compose of O I, N I and N_2 dependent on the observing position , vertical depth and various exterior changes. In this study, we investigate the temporal and spatial variation of dayglow spectra through the limb area.

The Radial Velocity Study of the Near Contact Binary BX Andromedae

Chung-Uk Lee[1], In-Woo Han[1], Kang-Min Kim[1], Chun-Hwey Kim[2]
[1]Korea Astronomy Observatory, Daejeon 305-348, Korea
[2]Dept. of Astronomy & Space Science, College of Natural Science and Institute for Basic Science Research, Chungbuk National University, Cheongju 361-763, Korea

By using BOES (Bohyunsan Observatory Echelle Spectrograph) of Korea Astronomy Observatory, spectroscopic observations of the near contact binary BX And were made during 26-27, Feb. 2003. A total of 38 line Echelle spectra were obtained and used as the basis for new radial velocities. Two different methods to derive radial velocities from each component were adopted and inter-compared using the CCF (Cross-Correlation Function) and the BF (Broadening Function) produced by cross-correlation and de-convolution method respectively. The former has been conventionally used and the latter has been recently advocated by Rucinski and his coworking group. Our results show that the BF gives double-lined radial velocities for the components, while just single-lined radial velocities for the primary (more massive and luminous) component were defined with the CCF. The differences between the CCF and BF were discussed. The new absolute dimensions of BX And were calculated by the combination of solutions of our new radial velocity curves with the photometric ones published by other previous investigators.

International Virtual Observatory Alliance

In Sung Yim, Hyun Il Sung, Sang Chul Kim, Sangmo Tony Sohn, Young Sook Ahn, Bong Gyu Kim
Korea Astronomy Observatory

We present the framework and research activities of the International Virtual Observatory Alliance. The International Virtual Observatory Alliance was established as an international research program in 2002, and 15 countries joined in the program so far. A virtual observatory is a portal system which provides researchers with astronomical information, developing databases from the previous research and observed results. A virtual observatory will play the role of actual observatories with the functions of data collection, archive, retrieval and storage. Thus, it is a fairly economical system eliminating expenses of construction and operation of real observatories. The International Virtual Observatory Alliance has leaded the world's virtual observatory project with international collaboration and advanced research activity. The international virtual observatory project is an international project enabling a totally new scientific research which is far beyond just simple collection and reutilization of observed data made by traditional astronomical data information centers. This article illuminates all the present status and research activities of the International Virtual Observatory Alliance leading major virtual observatories in the world and research activities of participating countries as well as our future directions of Korean Virtual Observatory with a comparative study.

Hydrodynamic Simulations of the 200-pc Molecular Ring

Myoung Won Jeon, Sungsoo S. Kim
Dept. of Astronomy & Space Science, Kyung Hee University

Longitude-velocity (l-v) diagrams of HI and CO gas in the central few hundred parsecs of the Milky Way have long been known to be inconsistent with circular motion in an axisymmetric potential. Many pieces of evidence suggest that the Galaxy is barred, and gas flow in a barred potential could be consistent with the observed "forbidden" velocities and other features in the data. We compare the HI observations to (l-v) diagrams synthesized from three-dimensional Smoothed Particle Hydrodynamics (SPH) simulation of gas flows in a family of barred potentials, and show that the simulation reasonably well predicts the observed gas and morphology of 200-pc molecular rings in the Milky Way.

BOES Spectroscopic Study of the Accretion Flow in the Symbiotic Star V1016 Cyg

Yangy-Chan Jung[1], Hee-Won Lee[1], Sook-Hyang Yi[2] and Sang-Hyeon Ahn[3]

[1]Dept. of Astronomy and Space Science & Astrophysical Research Center for the Structure and Evolution of the Cosmos, Sejong University
[2]Dept. of Earth Science Education, Korea National University of Education
[3]Korea Astronomy Observatory

We obtained a high resolution spectrum of the symbiotic star V1016 Cyg using the BOES (BOAO Optical Echelle Spectrograph), from which we secured the Raman scattered O VI 6825 and 7088. These features are formed through Raman scattering of OVI 1032, 1038 doublet by atomic hydrogen. Both features exhibit double peak profiles, but the quantitative analysis shows that the profiles differ in such a way that the blue part of the 7088 feature is relatively weaker. We adopt an accretion disk flow model proposed by Lee & Park (1999), where the white dwarf component captures a fraction of slow stellar wind originating from the giant component as a result of mass loss. We find that the disparate profiles can be explained if we take an eccentric gas flow around the white dwarf where the red emission region is more exposed to the UV continuum source than the blue emission region is. We provide our model profiles that gives a satisfactory fit to the spectroscopic data.

Light Element And Ni Abundance In Field Metal-Poor Stars

Hyun-jin Jeong[1], Jae-Woo Lee[2], Sug-Whan Kim[1] and A-Ram Kang[1]

[1]SOL, Dept. of Astronomy, Yonsei University

[2]Dept. of Astronomy and Space Sciences & Astrophysical Research Center for the Structure and Evolution of the Cosmos, Sejong University

We report chemical abundance measurements of 10 metal-poor halo giants and subgiants stars. Target stars include BD+06 0648, BD+54 1323, HD6755, HD6833, HD8724, HD25532, HD63791, HD74462, HD110184 and HD12256. The program stars have metallicities ranging from -0.5 to -3.0 The high resolution spectra of the program stars were obtained using the Bohyunsan Optical Echell Spectrograph with the #4-fiber at R=45000 and S/N>100 and the EEV CCD model 44-82 of 2048 x 4096 pixel format as the detector. The standard spectral data reduction technique employing a number of IRAF routines and the MOOG-Kurucz model atmosphere was used to estimate the mean elemental abundances. The abundance analysis was mainly concerned with the [O I] doublet(λ 6300, 6363) and the light metallic lines (e.g. Na Through Ti, except for Sc). The well-known excess of the alpha process elements in the halo field is clearly reproduced in our data for Ca, Si and Ti. These enhanced [O/Fe] and [α/Fe] values of metal-poor stars are interpreted as the significant contribution of SNe II nucleosynthesis to the proto-stellar material used for the formation of the program stars within the time scale of a couple of gigayears after the explosion. The sodium abundance analysis suggests two groups of giant stars, one from halo field and the other from globular cluster, do not share common star formation history.

Surface Brightness Fluctuations in GALEX UV Passbands as Population Indicators

Hye Jeon Cho and Young-Wook Lee
Center for Space Astrophysics and Dept. of Astronomy, Yonsei University

Surface brightness fluctuations (SBFs) have been used as distance indicators of extragalactic galaxies and probes of stellar populations. Theoretical predictions for SBF magnitudes and colors in the GALEX ultraviolet (UV) passbands are calculated using models from our evolutionary population synthesis code. Our models will be the first detailed study for UV SBFs of old population II stellar systems because there are no such models yet available in the literature. Our models cover wide ranges of ages from 5 to 17 Gyr and metallicities from [Fe/H]=-2.3 to 0.4. Since SBFs depend on the second moment of the stellar luminosity function, they are sensitive to the brightest stars in galaxies or clusters. Far-UV (1350-1800 Å) and near-UV (1800-3000 Å) SBFs are sensitive to the most luminous UV-emitting stellar population: hot horizontal branch (HB) stars and the post-HB progeny in the case of old population II systems. Therefore, if the distance is known, we can use UV SBFs to detect the temperature distribution of hot HB stars. We have shown that UV SBF magnitudes and colors may serve as a tool to estimate rough ages and metallicities of the unresolved old stellar populations since the HB morphology is sensitive to age and metallicity.

Eclipsing Binaries in the Central Bar of the Large Magellanic Cloud

Kyeong-Soo Hong[1], Choong-Uk Lee[2], Chun-Hwey Kim[2]
Kyu-Dong Oh[3], Young Woon Kang[1]
[1]Dept. of Astronomy and Space Science & Astrophysical Research Center for the Structure and Evolution of the Cosmos
Sejong University
[2]Dept. of Astron. and Space Science, Chungbuk National University
[3]Dept. of Earth Sciences, Chunnam National University

The three major survey observations have discovered over 3500 eclipsing binaries in the LMC. Eclipsing binary stars are of great interest because they have the potential for highly accurate studies of stellar parameters and evolution at low metallicity (e.g., Bell et al., 1991, 1993). In addition, extragalactic eclipsing binaries can be used as distance indicators (Guinan, 1993). We present follow-up observations of EROS 1017 in the central bar of the Large Magellanic Cloud to analyse the light curves of these eclipsing binaries in the LMC. The observations were carried out as one of the extra galactic binary observing program using the 2.1-meter Cassegrain reflector telescope in the CASLEO, Argentina. We have determined times of minimum light for EROS 1017 and derived an accurate period with six significant decimal places using an extended time baseline that combines EROS, OGLE, and our own observations. The shape of the light curve of EROS 1017 is half way between Algol type and β Lyr type. Our *BV* light curves of EROS 1017, observed in 2003 and 2004, have been analysed with the 1993 version of the Wilson & Devinney (WD) differential corrections code. The absolute dimensions have been estimated by adopting a distance to EROS 1017 of 47.5 kpc.

Accurate Absolute Dimensions and Distances of 10 Eclipsing Binaries

Kyeong-Soo Hong, Changdeok Hwang, Seunghwa Kook,
Yang-Chan Jung, Jungho Kim, Young Woon Kang
Dept. of Astronomy and Space Science & Astrophysical Research Center for the Structure and Evolution of the Cosmos
Sejong University

We present accurate absolute dimensions and distances 10 eclipsing binaries whose radial velocity curves were published by Popper. The optical light curves were collected from the literatures. First the preliminary photometric solutions were found from the light curves. Then temperatures of both components were reduced from their energy curves obtained from the IUE observations. The spectroscopic solutions were determined from the radial velocity curves observed by Popper who published more reliable radial velocity curves for selected binary stars after his retire. The three results, preliminary photometric solution, temperatures of both components, spectroscopic solution were combined to get simultaneous solutions. Finally the absolute dimensions and distances were determined for 10 eclipsing binaries. The distances were compared with those of the Hipparcus.

First Multi-color Light Curves of V473 Cas

Changdeok Hwang[1], Tae-yeon Jeong[1,2], Young-Soo Kim[3], Young Woon Kang[1]

[1]Dept. of Astronomy and Space Science & Astrophysical Research Center for the Structure and Evolution of the Cosmos
Sejong University
[2]Pungmoon Girls' High School
[3]Korea Astronomy Observatory

We present the *VI* light curves and times of minima of V473 Cas for the first time. The observations were carried out as one of the near-contact and contact binary observing program (NCOP) using 2K CCD camera attached to the 60-cm Cassegrain reflector telescope in the Mt. Soback Observatory. We developed the software for "selection of comparison stars for the variable stars" to construct a light curve of new variable stars discovered by CCD photometry. The software gives a list of comparison stars with least variation as well as new variable stars if discovered. The light curves show a typical β Lyr type and a high degree of asymmetry. A new light element were calculated using the times of minima determined in this work. The asymmetric light curves were analyzed by the spot model.

Acoustic p-mode spacing and splitting in enigmatic rapidly-oscillating chemically peculiar magnetic star HD101065 (Przybylski's star)

David E. Mkrtichian[1], Artie P.Hatzes[2]
[1]Astrophysical Research Center for the Structure and Evolution of the Cosmos Sejong University, Korea
[2]Thringer Landessternwarte Tautenburg, Tautenburg, Germany

The HD 101065 (Przybylski's star) is the most enigmatic chemically peculiar star in the sky having +4-5 dex overabundances of lantanides (Przybylski,1961). Recently the radioactive elements (actinides) were found to be widely present in atmosphere of Przybylski's star (Cowley, 2004, Gopka et al., 2004). The nature of such a strong anomalies is still unexplained Przybylski's star was the first rapidly-pulsating magnetic (roAp) star ever discovered.We started the project for checking the diffusion theory and determination the atmospheric chemical profiles using the new technique of acoustic cross-sections of atmospheres (Mkrtichian et al., 2003)
We present the first results of precise radial velocity (RV) studies of Przybylski's star (V=8.02) obtained using the recently commissioned HARPS spectrograph on the ESO's 3.6m telescope taken during nights March 2-6, 2004. For the first time for Przybylski's star we have detected the rapid multimode RV-variations with period around 12.1 min. The RV acoustic mode detection threshold was about 5 m/s. The maximum oscillation RV amplitude (using all spectral lines) is about 200 m/s. We find three dominant p-modes equally-spaced each other on 48.5 Hz. We assume that this spacing is a half of fundamental spacing 97 Hz between consecutive overtones and indicates close to ZAMS status of the star. Two high amplitude principal modes show the rotational splitting and represents the triplets and doublets. Using the splitting of modes we find the rotation period of star P=1.7 days. This lead to conclusion about pole-on visibility of the star. The detailed spectral line-by-line analysis is in progress.

Distance and accreton luminosity of the long-period eclipsing polar V1309Ori

Klaus Reinsch[1], Yonggi Kim[2], Klaus Beuermann[1]
[1]Universitaets-Sternwarte Goettingen, Goettingen University, Germany
[2]Dept. of Astronomy and Space Sciences, Chungbuk National University, Korea

We have obtained quasi-simultaneous near-infraed light curves of the long-period eclipsing polar V1309Ori in the J, H, K bands with almost complete orbital phase coverage using the CFHT-IR camera. The shape and the amplitude of the orbital light curve change sihnificantly from optical to near-infrared wavelengths. While in the optical the light curve is dominated by the emissioncharacteristics and the projected area of the accretion stream photosperic emission of the late-type secondary star becomes increasingly important at longer wavelengths. The J, H, and K band phases 0.95 and 0.05 which becomes shallow in K. The full amplitudes of the orbital modulation are 0.62 mag in the J band and 0.46 mag in the H and K bands (compared to 1.88 mag in V). This contradicts the analysis of the origin of the infrared light by Harrop-Allin et al. (1997) and yields a distance to V1309Ori consistent with that derived from the optical flux of the secondary star.

Chemical Abundances for Seven Giant Stars In M68 (NGC 4590)

Jae-Woo Lee
Dept. of Astronomy and Space Sciences & Astrophysical Research Center for the Structure and Evolution of the Cosmos, Sejong University

We present a detailed chemical abundance study of seven giant stars in M68 including six red giants and one post-AGB star. We adopt an iron abundance using photometric gravities and Fe II lines to minimize those effects, finding [Fe/H] = -2.16. We find variations in the abundances of sodium among the program stars. However, there is no correlation (or anti-correlation) with the oxygen abundances. Further, the post-AGB star has a normal (low) abundance of sodium. Both of these facts add further support to the idea that the variations seen among some light elements within individual globular clusters arises from primordial variations, and not from deep mixing. M68, like M15, shows elevated abundances of silicon compared to other globular clusters and comparable metallicity field stars. But M68 deviates even more in showing a relative underabundance of titanium. We speculate that in M68, titanium is behaving like an iron-peak element rather than its more commonly observed adherence to enhancements seen in the ``α" elements such as magnesium, silicon, and calcium. We interpret this result as implying that the chemical enrichment seen in M68 may have arisen from contributions from supernovae with somewhat more massive progenitors than contribute normally to abundances seen in other globular clusters. M68 shares the same [Ba/Eu] ratio as the stars in M15, but the average abundance ratio of these elements, and lanthanum, are lower in M68 relative to iron than in M15, implying a slightly weaker contribution of *r*-process nucleosynthesis in M68.

The Solar Eclipse Predictions of Chiljeongsan-Oepyeon in Choseon Dyn.

Young Sook Ahn[1], Yong Sam Lee[2]
[1]Korea Astronomy Observatory, Daejeon, 305-347, Korea
[2]Chungbuk National University, Cheongju, 361-763, Korea

Eastern history books about astronomical phenomena have the more records of the solar eclipse frequently than any other ones. It is because traditionally, the solar eclipse meaned the fate of dynasty and the king's rule. The Sun, the biggest thing in the heaven symbolized the king, and the solar eclipse foresaw that the king had the problem in private including the body and the country might suffer from difficulties in a great scale. So the king and all of the ministers used to gather to hold a ceremony named Gusikrye (求食禮) which solar eclipse may pass safely. Consequently, kings always had concernments on collecting informations of solar eclipse. Inspite of importance of solar eclipse predictions, but at the beginning of the Choseon, the predictions of the solar eclipse didn't fit. King Sejong compiled the Chiljeongsan-naepion (七政算內篇) and the Chiljeongsan-oepyeon (七政算外篇) to calculate the celestial phenomena including the solar eclipse. By the publications of these two books, the calendar making system of Choseon was firmly established. This thesis describes the way to calculate the solar eclipse by Chiljeongsan-oepyeon which was used frequently on early and middle period of Choseon, investigates the accuracy of the predictions of the eclipse.

The research of five planets diagrams in the Jegdo-nambuk-chongseongdo (=赤道南北總星圖)

Gil Sun Oh[1], Young Sook Ahn[2]
[1]767-7, Hyoja-2 dong, Chunchon City, Kangwondo, Korea
[2]Korea Astronomy Observatory, Daejeon, 305-347, Korea

Jegdo-nambuk-chongseongdo(= The Equatorial south and north complete star map, 赤道南北總星圖) was made by Adam Schall (=Chinese name: 湯若望) in 17th centuries. This star map display the constellations of north and south celestial sphere in the central part. And the 10 diagrams for the movement of five planets and the 4 diagrams of astronomical instruments are around the celestial spheres. In 1708 the bureau of Astronomy(= Gwansanggam, 觀象監) prepared a copy of the Jegdo-nambuk-chongseongdo(赤道南北總星圖) and presented it to the King SookJong. No copy of this chart, known by the name of Keonsangdo(乾象圖) in Choseon, is extant. It was probably the first duplicate in Choseon dynasty of a star map prepared under Western influences. This map composed with six-fold screen. But the original Chinese star map was a folding screen with eight panel. The 1st and 8th screen might be omitted in Keonsangdo. The contents of five planets diagrams are studied and verified the recorded astronomical phenomena in diagrams by modern astronomical calculations.

ACCURACY OF GNOMONIC MEASUREMENTS IN KOREA AND CHINA

Eun-Hee Lee[1], Kwan-Yu Chen[2]
[1]Yonsei University Observatory, [2]University of Florida

Measurements of the shadows casting by the noon sun with gnomon (圭表) had been an old practice since ancient time, for determining the positions of the sun and thus its annual motion. This practice in the Far East was declined with the infusion of western astronomy in the seventeenth century. This paper is an effort to examine the accuracies of some gnomonic measurements in Korea and China. Results of calculations of the lengths of the shadows are used as the relative standard. Each calculated value is based on the latitude of the place, the date of observation, and the obliquity of the ecliptic. Also the celestial longitude of the sun for the date is known from catalogue. Then the difference of each observed shadow length and the computed value is known. In general, these differences are small. One simple cause for the deviation could be the tilting of the gnomon.

Astronomical Observation as a practical experience learning program

Dong-Joo Han, Yonggi Kim
Dept. of Astronomy and Space Sciences, Chungbuk National University, Korea

It is highly needed to provide a practical experience learning program in field because of the 5 days work system in korea. It seems that training programs, class activities or family camps during the weekend will be provided in future as a practical experience learning program. Astronomy is suitable to present the basic facts of scientific methodology and reasoning to the public. Therefore we propose a astronomy program teaching basic astronomy and space sciences to the general public as well as school groups. We also tried to construct a network program connecting regional facilities which have astronomical observaton systems.

OECD Global Science Forum Near Earth Object International Steering Committee Progress Report

Hong-Kyu Moon[1], Wonyong Han[1], Hong-Suh Yim[1], Yong-Ik Byun[2]
[1]Korea Astronomy Observatory, Yusong, Taejon 305-348, Korea
[2]Yonsei University Observatory, Yonsei Univ., Seoul 120-749, Korea
Email: fullmoon@kao.re.kr

In the sixth GSF meeting, Near Earth Object (NEO) International Steering Committee was formed, in which eight member countries, including Korea, agreed to hold **Workshop on Near Earth Objects : Rsiks, Policies and Actions** in January 2002, in Frascati, Italy. The workshop was attended by government-appointed delegates from fifteen GSF member countries, representatives of three inter-governmental organizations, and invited speakers. In April 2003, OECD distributed the final report of the workshop to the OECD member countries; findings and conclusions focus on policies related to NEOs, and actions that governments, inter-governmental organizations, and scientific organizations can undertake, separately and jointly, at national and international levels. We presented an introduction to Korean NEO program during the Frascati workshop. The final report of the workshop emphasized observations carried out in the southern hemisphere are particularly important ; Korean effort is part of an ongoing international campaign to discover and follow up NEOs, especially in the southern hemisphere. The committee is now undertaking first order analysis on ocean/land impact risk due to NEOs. The drivers for this study are: need to formulate a science-based policy on the NEO hazard; need for governments to be able to compare NEOs with more familiar, natural and man-made hazards. They adopted a computational methodology to address such factors as the country's size, topography, proximity to the ocean, population distribution, economic infrastructure and vulnerability to natural hazards. GSF will provide the final results as input to International Council for Science (Nov 2004) and UN Committee on the Peaceful Uses of Outer Space (Feb 2005). We present Korean NEO efforts and the recent activities of the NEO International Steering Committee.

A study of mechanical design and thermal analysis of KAONICS (KAO Near-Infrared Camera System)

Bongkon Moon, Jina Kang, Sungho Lee,
In-Soo Yuk[1], Ho Jin, Kwang-Il Seon, Soojong Pak
[1]Korea Astronomy Observatory
[2]Department of Astronomy and Space Science, Chungnam National University

We present the mechanical design concept and thermal analysis for KAONICS(KAO Near Infrared Camera System). In order to observe infrared sources, it is required to cool the cold box and the detector box down to 80K and 30K respectively. Therefore, we calculate thermal load for this system, then chosen a cryocooler which has moderate cooling capacity. A cryostat include cold-box, radiation shield panel. All of optical components, detector housing and filter wheel are mounted in the a rectangular cold box. we consider a vibration isolation assembly between cooler and cryostat and a method to protect the optical axis distortion according to temperature variation.

Optical Alignment of KAO Wide Field Telescope (NEOPAT)

In-Soo Yuk, Jae-Mann Kyeong, Joh-Na Yoon, Jae-Hyuck Yoon, Hong-Suh Yim, Hong-Kyu Moon, Wonyong Han

Korea Astronomy Observatory

We presents a result of optical alignment of KAO wide field telescope (NEOPAT, Near Earth Object and Satellite Patrol). The main mission of NEOPAT is finding and tracking near earth objects and satellites. NEOPAT has f/2.5 prime focus and its diameter is 60cm. NEOPAT is installed temporary at the top of DRAO main building to develop automatic observation and normalize system performance. Because NEOPAT is wide field telescope, the optical efficiency is very sensitive to the status of optical system. In order to align optical system accurately, we measure the abberations of the telescope quantitatively by means of curvature sensing technique (CST). The optical property of NEOPAT will be shown.

Automatic observaton and control system with MEADE LX 200

Joh-Na, Yoon[1,2], Chung-Uk Lee[2], Sang-Mok Cha[1],Yonggi Kim[1]
[1]Dept. of Astronomy and Space Sciences, Chungbuk National University, Korea
[2]Korea Astronomy Observatory, Daejon, 305-348, Korea

We have contructed the automatic system which can control the ash dome and the CCD dectector for the MEADE LX 200 (16″) at Chungbuk National University. This is the first step for the contruction of the remote observaton system. This system can open the dome and start the observaton system automatically if the weather allows to observe the stars as well as shut down the observation system and close the dome in the case the bad weather. We will show some test data from our automatic observations.

Optics Design of the KAO Near Infrared Camera System (KAONICS)

Sungho Lee[1], In-Soo Yuk[1], Jeong-Yeol Han[1,2],
Bongkon Moon[1,3], Soojong Pak[1], Ho Jin[1]
Jeong-Gi Lee[4], Cheon-Seog Rim[4]

[1]Korea Astronomy Observatory
[2]Department of Astronomy and Space Science, University of Science and Technology
[3]Department of Astronomy and Space Science, Chungnam National University
[4]Department of Physics, Hannam University

Korea Astronomy Observatory (KAO) is developing the KAO Near Infrared Camera System (KAONICS). We are designing the optical system of the KAONICS which will be installed on the 61-cm optical telescope of the Ritchey-Chretien type at the Sobaeksan Optical Astronomy Observatory (SOAO). KAONICS will be equipped with a 512x512 InSb array and 1-4 um braodband filters for near-infrared imaging observations. Since the telescope is optimized for observations at visible wavelengths, a cold Lyot stop is necessary for rejecting stray light from warm structures of the telescope like sky baffles. An Offner relay should be the best choice for the optical system of KAONICS because of the advantages of a Lyot stop provided by the cold secondary, no chromatic abberation over whole wavelengths, and the compact size of the system, etc. The Offner mirrors will be made of aluminium which is the same material as for the mechanical mounts in order that the optical performance is not affected by thermal contraction to cryogenic temperature.

CME geoeffectiveness according to its orientation and chirality

Seung-Mi Kang [1,2], Young-Jae Moon[2] and kyung-sok,cho[2]

[1]Department of Astronomy and Atmospheric Sciences, Kyungpook National University

[2]Korea Astronomy Observatory

Coronal mass ejections (CMEs) have been regarded as a major solar disturbance which results in geomagnetic storms, especially when there exist southward components of the interplanetary magnetic field (IMF). In this study, we have examined the CME geoeffectiveness characterized by the Dst index in terms of the field orientation (N or S) and the sigmoidal shape (S or Inverse-S) of solar active regions. In determining the field orientation we have applied the coronal flux rope model to solar active regions producing 62 CME-ICME pairs from 1996 to 2001 using Yohkoh/SXT and SOHO/MDI images. As a result, we present several contingency tables of the CME geoeffectiveness according to the field orientation and the sigmoidal shape. We find that while the southward inverse-S shaped sigmoid is an important factor for CME geoeffectiveness (Dst < -100nT), the orientation in the case of an S-shaped sigmoid is not critical at all.

High-latitude Thermospheric Winds and Momentum Forcing: Dependence on the Interplanetary Magnetic Field

Young-Sil Kwak[1], Byung-Ho Ahn[2] and Arthur D. Richmond[3]

[1]Dept. of Astronomy and Atmospheric Science, Kyungpook National University

[2]Dept. of Earth Science, Kyungpook National University

[3]High Altitude Observatory, NCAR, Boulder, CO, USA

At high-latitude thermospheric winds are forced primarily by non-uniform solar heating, atmospheric tides and other waves coming from below, and energy and momentum sources associated with magnetosphere-ionosphere coupling, such as the magnetospheric convective electric field and the precipitation of energetic electrons and ions into the auroral regions. To understand the physical processes that control the high-latitude thermospheric dynamics, we quantify the forces that mainly contribute to maintaining the high-latitude thermospheric wind system, and we also examine the resulting momentum force balance with the aid of the National Center for Atmospheric Research Thermosphere-Ionosphere Electrodynamics General Circulation Model (NCAR-TIEGCM). Momentum forcing is statistically analyzed in geomagnetic coordinates, and its behavior with respect to the magnitude and orientation of the interplanetary magnetic field (IMF) is further examined in this study. Differences between winds and forces for different IMF orientations are analyzed.

Conversion of Ordinary Waves into Upper Hybrid Waves in Inhomogeneous Plasmas

Kyung-Sub Kim, Eun-Hwa Kim, Dong-Hun Lee
Dept. of Astronomy and Space Science Kyung Hee University

Linear mode conversions of ordinary(O) waves into upper hybrid(UH) waves have been investigated by using a three-dimensional fluid numerical model. Where an one-dimensional inhomogeneous density profile is assumed in a cold and magnetized plasma. The density gradient is taken to be perpendicular to the magnetic field. An impulsive input is assumed to excite the O waves in the inhomogeneous box model. In order to solve an initial-valued problem, the finite difference method is used in both time and space. The wave spectra of electric and magnetic field components are presented. We show that how the mode conversion appears by analyzing time histories of both electric and magnetic field components. Our results suggest that the electromagnetic(EM) wave energy of O wave is converted into the UH electrostatic(ES) energy wherever the resonant condition, upper hybrid resonance(UHR), is satisfied.

Propagation of Nonlinear Magnetosonic Waves

Kyung-Im Kim[1], Sungsoo S. Kim[1], Dong-Hun Lee[1],
Kihong Kim[2]

[1]Dept. of Astronomy and Space Science, Kyung Hee University
[2]Dept. of Molecular Science and Technology, Ajou University

We perform simulations of propagation of nonlinear magnetosonic waves using one and two dimensional MHD codes of Total Variation Diminishing(TVD) scheme. A magnetosonic wave is a longitudinal wave propagating perpendicularly to the magnetic field lines, and involves compression and rarefaction of the magnetic field lines and the plasma. We first confirm the theoretical solution of Lee and Kim (2000) for the evolution of nonlinear magnetosonic waves in the homogeneous space. We then extend our simulations to magnetosonic waves in one-dimensional inhomogeneous space and in two-dimensional homogeneous space that are triggered by a localized impulse.

Solar Wind Dynamic Pressure during Magnetic Storms and Its Implications on the Dayside Ring Current Particle Loss

Kyungchan Kim[1], D.-Y. Lee[1], Ensang Lee[2]
[1]Department of Astronomy and Space Science
Chungbuk National University, Cheongju, South Korea
[2]Space Sciences Laboratory
University of California, Berkeley, CA, USA

It has been known that (untrapped) ring current particles can be lost through the dayside MP(magnetopause) into the magnetosheath. However, details of the loss mechanism of this process have not received much attention. In this paper, we show that the solar wind dynamic pressure can play a significant role in the dayside loss. In order to show that, we have first analyzed the average characteristics of the 95 geomagnetic storm events selected from the period 1997 to 2002. We find that the dynamic pressure overall enhances during the magnetic storm. The enhancement is most significant during the storm main phase and it is higher for stronger storms. Using one of the most recent Tsyganenko models, T01_s, we show that this enhanced dynamic pressure not only pushes MP to move inward but also sets an enhanced gradient of the magnetic field intensity along the MP. On the basis of the test particle calculation, we explicitly show that the increased gradient of the magnetic field intensity along the MP can be a significant factor for the particles to effectively cross the MP by the gradient-drift. We argue that this can often apply to the majority of the ring current particles.

The effect of slow recombination of H_3^+ on the Jovian ionosphere

Yong Ha Kim[1] and Tae Seog Yoon[2]

[1]Dept. of Astronomy and Space Science, Chungnam National University
[2]Dept. of Astronomy and Atmospheric Sciences, Kyungpook National University

Recently the recombination reaction of H_3^+ ion with electron is reported to be very slow process with a rate coefficient of $3*10^{-9}$ cm^3s^{-1}, 100 times slower than value used in most Jovian ionosphere models. The slow recombination leads to about 10 times increase in H_3^+ densities, which may explain observed intensities of 3.5 micron H_3^+ emission from the mid-latitude Jovian ionosphere without proposing additional ionization source for H_3^+. Since H_3^+ ion is regarded as the major ion in the F_2-region of the Jovian ionosphere, the slow recombination may also cause F_2-region electron densities more susceptible to temperature variation and vertical drift due to dynamical process such as gravity wave propagation. Temperature variation in the upper thermosphere can result in drastic change of H^+ densities in the F_1 -region via endothermic reaction between H^+ and H_2. Some of electron density profiles of the Jovian ionosphere, measured by radio occultation experiments of Pioneer, Voyager and Galileo spacecraft, may be explained with the H_3^+ slow recombination, temperature variation and vertical drift from dynamical processes. We will show the range of chemical and dynamical parameters searched in ionosphere models that are consistent with the infrared H_3^+ observation and radio occultation experiments.

Effects of heavy ions on ULF waves in the magnetosphere

Eun-Hwa Kim and Dong-Hun Lee
Dept. of Astronomy and Space Sciences, Kyung Hee University

We present a simulation study of the propagation of ULF waves in the magnetosphere when multi-ions such as helium and oxygen ions are present. Since the inclusion of multi-ions facilitates the propagation of waves for the band of frequency below each ion gyro-frequency, a multi-fluid treatment is required. We adopt a three-dimensional multi-fluid model, which can fully include the effects of multi-ions and electron. In a box model of an inhomogeneous plasma, we examine the resonant absorption through mode conversion when the MHD approximations break down. The wave spectra and energy relations are presented for ion cyclotron waves of helium and oxygen ions. In addition, the role of plasma composition in the wave coupling problem is investigated in detail. We discuss and compare our results with the previous theoretical and numerical studies.

The correlation between solar EUV flux and plasma characteristics in the low-latitude topside ionosphere at nighttime

Heejun Kim, Jaeheung Park, Kyoung W. Min
Department of Physics, Korea Advanced Institute of Science and Technology

We present the result of the correlation between solar EUV flux and ionospheric plasma parameters observed by KOMPSAT-1 (685 Km altitude, 2250 local time), DMSP F-13 (840 Km altitude, 1830 local time) and DMSP F-15 (840 Km altitude, 2130 local time) in the low-latitude topside ionosphere. The plasma density and temperature observed by KOMPSAT-1, DMSP F13 and DMSP F15 from June 28, 2000 to August 1, 2001 were analyzed with F10.7 which is a standard proxy for solar EUV flux. Especially, the data of the geomagnetic latitude between -60° and 60° in the nighttime were considered at the low- and mid-latitude region. The result shows that the plasma density and temperature increased with F10.7 at the region observed by these satellites. Furthermore, the best correlation between F10.7 and plasma parameters was observed with a lag of 2 or 3 days. It means that the ionospheric equatorial plasma is influenced by the solar EUV flux with a delay of 2 or 3 days.

KAO space weather monitoring system : II. Real-time data acquisition tools and applications

Hyungmin Park, Yong-Jae Moon, Kyung-Seok Cho, So-Young Park, Woo-Kyoung Lee, Young-Deuk Park and Yeon-Han Kim

Korea Astronomy Observatory

Recently, real time data acquisition become important for space weather forecast and research. In this work, we have developed the data acquisition tools and their applications for space weather monitoring. The tools consist of IDL widget programs to download the data and ION (IDL on the Net) programs to display the data. By using these tools, we have constructed the mirror site of Active Region Monitor (ARM) which summarizes several different solar activities, and developed ION programs to display TEC(Total Electric Contents) maps at the passage of Korean satellites. At present, the KAO ARM mirror site (http://sun.kao.re.kr/arm) is successfully updated in every thirty minutes. The TEC maps from GPS data are expected to be used for monitoring the space environment of Korean satellites.

KAO Space Weather Monitoring System: III. Nowcast, Forecast and Database

So-Young Park[1], Kyung-Seok Cho[1], Yong-Jae Moon[1], Hyungmin Park[1], Roksoon Kim[1,2], Jung-Eun Hwangbo[1,3], Young-Deuk Park[1,4], and Yeon-Han Kim[1]

[1]Korea Astronomy Observatory, Korea
[2]Dept. of Astronomy and Space Science, Chungnam National Univ., Korea
[3]Dept. of Astronomy and Space Science, Chungbuk National Univ., Korea
[4]Big Bear Solar Observatory, NJIT, USA

Nowcast and forecast based on realtime data are quite essential for space weather monitoring. In this work, we have developed the web pages of the KAO space weather monitoring system by using ION (IDL on the Net). They display latest solar and geomagnetic data, and present their expected effects on satellite, communications and ground power system. In addition, daily NOAA/SEC prediction reports on the probability of solar X-ray flares, proton events and geomagnetic storms are given. To predict the arrival times of interplanetary shocks and CMEs, two different types of prediction models are also implemented. Now we are making web-based data base of several solar and geomagnetic activities. These data are automatically downloaded to our data server in every minute, or every day using IDL and FTP programs.

Equatorial Plasma Bubbles in the Premidnight Sector During Solar Maximum as Observed by KOMPSAT-1

Jaeheung Park[1], Kyoung-Wook Min[1], Vitaly P. Kim[2], Hee-Jun Kim[1]

1Department of Physics, KAIST, Daejeon 305-701, Korea
2IZMIRAN, Moscow Region, Russia
E-mail: jhpark@space.kaist.ac.kr

KOMPSAT-1 observed nighttime upper ionosphere from June 2000 to August 2001, when the solar cycle reached its maximum. We present here the results of statistical analysis about the equatorial plasma bubbles detected by KOMPSAT-1. In our observation, the bubbles occurredat all longitudes in the equinoctial seasons with peak occurrence in the south American-Atlantic-African region. During the northern summer, they predominantly occurredat the north of the magnetic equator in the Indian and West-Pacific regions. During the northern winter, most bubbles occurred in a narrow region of South America and bubbles were scarcely seen in the Pacific region. Using empirical models, we calculated the linear growth rates of Rayleigh-Taylor instability, and compared them with the observation. In our results, the growth rates could notreproduce the bubble distribution at the topside ionosphere. On the contrary, a new parameter, defined as a product of upward plasma drift and flux-tube electron content at the bottomside F region, could represent the seasonal-longitudinal variation of the bubble occurrence.We suggest this new parameter has relation to the degree of turbulence of the bottomside ionosphere.

The ionospheric variation of radio waves on the Korea Peninsula

Sung-Bok Baek[1], Dong-Hun Lee[1], Yoo-Surn Pyo[2]
[1]Dept. of Astronomy and Space Science, Kyung Hee Univ.
[2]Ministry of Information and Communication Radio Research Laboratory

The Ionospheric variation is important in radio propagation. A ray tracing code for short distance propagation via the ionosphere has been established and applied with monthly average electron density profiles at 0300 and 2000 UT (UT = LT + 9hr) Jan. / Aug. 2002. taken from the ionosonde at Anyang (37.39° N, 126.95° E) and IRI-2001 using URSI coefficients so as to verify the ionospheric variation of radio waves. The simulation results applied with ionosonde electron density profile were compared with ones applied with the other. When comparing reaching frequencies and departure angles within 500km from a transmitter point good agreement was found in spite of a difference of electron density profile.

A statistical study of solar wind dynamic pressure enhancements during geomagnetic storms

Ji-Hye Baek, Dae-Young Lee

[1]Dept. of Astronomy & Space Science, Chungbuk National University

In this work we have examined the statistical characteristics of solar wind dynamic pressure enhancements during the storm main phase. To identify storms, we have used the Dst index and have obtained a total of 111 storms in the time interval of 1997 to 2001. For the main phase interval of each storm, we have identified the dynamic pressure pulses by looking at the low latitude ground H data as well as the solar wind pressure data themselves. To supplement our analysis, we have also used the GOES geosynchronous magnetic field data. Our statistical analysis leads to the following results: (1) The average change in low latitude H tends to be proportional to the Dst magnitude which is in turn proportional to the occurrence frequency of the dynamic pressure during the given storm phase interval; (2) For about 30 % of our storms, the occurrence frequency of the pressure enhancement is greater than 0.4 #/hr the inverse of which is about an average substorm period, ~2.5 hrs; (3) We find that 104 out of 111 storms are associated with interplanetary shocks (IPS). 72 of them are driven by CMEs, 7 by corotating interaction regions, and 8 of them are classified into blast-wave-type shock, the remaining 17 are unidentified; (4) In many of the IPS-associated storm events, the main phase interval corresponds to the IPS sheath and leading region of CMEs, suggesting that the frequent pressure enhancement originates from these regions due to some mechanism.

The effect of dust particles on ion acoustic solitary waves in a dusty plasma

Cheong Rim Choi, Dae-Young Lee & Younggi Kim
Dept. of Astronomy & Space Science, Chungbuk National University

In this paper we have examined the effect of dust charge density on nonlinear ion acoustic solitary wave which propagates obliquely with respect to the external magnetic field in a dusty plasma. For the dusty charge density below a critical value, the Sagdeev potential  has a singular point in the region $n<1$, where n is the ion number density divided by its equilibrium number density. If there exists a dust charge density over the critical value, the Sagdeev potential becomes a finite function in the region $n<1$, which means that there may exist the rarefactive ion acoustic solitary wave. By expanding the Sagdeev potential in the small amplitude limit up to  near $n=1$, we find the solution of ion acoustic solitary wave. Therefore we suggest that the dust charge density plays an important role in generating the rarefactive solitary wave.

Angles Only Orbit Determination From Single Tracking Station

Byoung-Sun Lee and Yoola Hwang
Satellite Ground Control Technology Team, ETRI
Daejeon 305-350, Korea
E-mail: lbs@etri.re.kr

Satellite orbit determination using angles only data from single ground station is carried out. The KOMPSAT-1 satellite mono-pulse angle tracking data from 9-meter S-band antenna at KARI site in Daejeon is used for the orbit determination. Various angle tracking arcs from one-day to five-day are processed and the orbit determination results are analyzed. Antenna pointing data are predicted based on the orbit determination results to check the possibility of re-acquisition and tracking of the satellite signal. Normal satellite mission operations including orbit determination, antenna prediction, satellite re-acquisition and automatic tracking from predicted antenna angle pointing data are concluded to be possible when three-day angle tracking data from single tracking station are used for the orbit determination.

Launch Stage Thermal Analysis for Satellite Box Under Two Extreme Thermal Conditions By Using Analytical Approach

Hui-Kyung Kim, Joon-Min Choi, Bum-Seok Hyun,
Jang-Joon Lee, and Hak-Jung Kim
Satellite Core Technology Group. Korea Aerospace Research Institute, Daejeon, 305-333, Korea
E-mail: jmchoi@kari.re.kr

Simple methods are developed to predict temperatures of a satellite box during launch stage. The box is mounted on outer surface of satellite and directly exposed to space thermal environment for the time period from fairing jettison to separation. The present study investigates analytical solutions for the worst cold case thermal analysis as well as the worst hot case thermal analysis. Specifically, the present study delivers how to determine heater size and predict the heater power consumption for the worst cold case while it predicts the maximum temperature for the worst hot case. These simple methods are to solve a 1st order ordinary differential equation (ODE) which is simplified from the governing equation. The present methods can be used as tools to determine heater size and to quickly check whether a satellite box is safe against space environment during the launch stage.

Service & Network Operation of The Multibeam Switching Satellite Communications System

Kyung Soo Choi, Cheon Sig Sin, Jin Ho Jo, Yong Min Lee and Seong Pal Lee

Communications Satellite Development Group, ETRI, Daejon, 305-350 Korea

E-mail: cks63894@etri.re.kr

The multibeam switching satellite system technology have started localized development to overcome the limitation of the frequency resource and geostationary orbit existing relay type satellite transponder and the required performance of the spot beam, and looked around the configuration and functions of the multibeam switching satellite communication system. This paper proposed that operation scheme and network control features for service definition, network architecture, transmission method of the natural disaster service network and public communication service network using this system.

Development of Performance Simulation Software for Satellite Reaction Control Thruster

Cho Young Han, Moon Gyung Nam and Eung Sik Park
COMS (Communication, Ocean and Meteorological Satellite) Program Office,
Korea Aerospace Research Institute

The reaction control thrusters are widely used for the satellite on-board chemical propulsion system fulfilling requirements for various missions in space. The most common reaction control thruster is the hydrazine thruster, which uses a hydrazine as a monopropellant. It has outstanding features caused by the nearly limitless restart capability and the very high reliability. The sole type of a monopropellant thruster used in nation is the monopropellant rocket engine-1 (MRE-1). The flight-proven MRE-1 thruster is a standard component of NASA and provide a nominal BOL maximum steady-state thrust of 4.45 newtons and a minimum EOL thrust of 0.9 newton. The nominal, steady-state specific impulse ranges from 221 to 202 seconds over the thruster inlet range of 2137 kPa to 448 kPa. Due to the growing complexity of the satellite mission, the needs for thrusters with the diverse performance are being increased. The numerical simulation could give useful information to develop a new type of thruster instead of relying on high cost and even dangerous tests. Therefore it is critical to make a reliable computer code to prepare the design improvement of a thruster. In this work, the performance analysis and validation of the satellite monopropellant hydrazine thruster currently used is accomplished as preliminary study to serve valuable data for future performance improvement by design change.

Basic Design Analysis of Rocket Test Facility for KSLV Propulsion Unit

Sun-Il Kang, Jung-Ho Lee, Yong-Wook Kim and Seung-Hyub Oh

Propulsion System Department, Korea Aerospace Research Institute

KARI(Korea Aerospace Research Institute) is achieving the KSLV(Korea Small Launch Vehicle) program according to National Space Technology Development Program. In this paper, the authors are intend to introduce the Rocket Test Facility(RTF) for Integrated Propulsion System(IPS) which will be constructed for the various tests on KSLV program. Using this facility, KARI can verify the adaptiveness of parts and subsystems for launch vehicle and finally can qualify the system characteristics of launch vehicle doing kinds of test including hot firing test. And finally, KARI can simulate the vehicle launching circumstances for using RTF and it make to predict the performance of launch vehicle when its flight test.

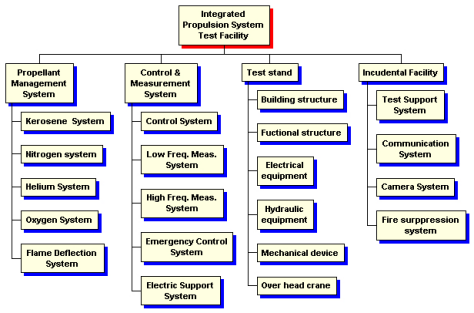


Fig. 1 Configuration of RTF

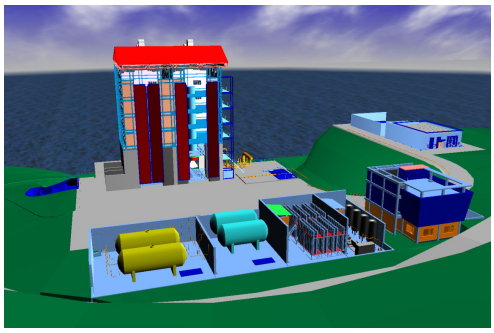


Fig. 15 Site Lay-out

The Cryogenic Regulator Design for Liquid Propulsion System

Gyoung-sub Kil, Joong-Youp Lee, Han-Bee Na,
Byung-Hun Kim and Young-Gab Chung
Control Systems Dept, Korea aerospace research Institute

The regulator that was designed for space use must be operating on the severe circumstance. For example, operating temperature is below 90K and operating pressure is 20.7MPa. The design of regulator for liquid propulsion system was accomplished and dynamic characteristic was analyzed successfully.

A Conceptual Design for Electrical Grounding Architecture of Korean Space Launch Vehicle

Kwang-Soo Kim[1], Soo-Jin Lee[1], Keun-Soo Ma[2],
Myoung-Ho Shin[1], Seung-Hyun Hwang[1], Ki-Man Ji[1],
Eui-Seung Chung[1]

[1]Dept. of System Design & Integration, Korea Aerospace Research Institute
[2]Dept. of Electronics, Korea Aerospace Research Institute

Electrical grounding is defined as referencing an electrical circuit or a common reference plane for preventing shock hazards and for enhancing operability of the circuit and EMI control. In order to realize the best electrical grounding system of korean space launch vehicle, we should design the electrical grounding architecture of korean space launch vehicle of system-level at the earliest point in design procedure. To minimize the electrical grounding loop and the unnecessary electromagnetic interference or radiation among the electronic subsystems, we should establish the electrical grounding rules of the all electrical interfaces. The electrical interfaces among the electronic subsystems are generally classified into the electrical power and signal interfaces. Because of using the primary and secondary power system architecture in the korean space launch vehicle system such as the common space launch vehicle systems, we need to establish the electrical grounding rules between the primary and secondary power system. We also need to establish the electrical signal grounding interface rules among the electronic subsystems. In this paper, we will describe the grounding schemes of the common space launch vehicle system and propose a conceptual design for the electrical grounding architecture of korean space launch vehicle system.

Development of Tracking Systems Applicable To Space Launch Vehicle

Sung-Wan Kim, Soo-Seul Hwang and Jae-Deuk Lee
Korea Aerospace Research Institute, Daejeon, 305-333, Korea
E-mail: sungwan@kari.re.kr

Tracking systems for launch vehicle consist mainly of radar transponder(beacon), RF switch or power divider, antennas as onboard system, and single or multiple radars as ground one. In this paper, tracking systems, which are applicable to KSLV(Korea Space Launch Vehicle)-1, are introduced and the electrical performances for developed prototypes are presented. We have also performed RF link analysis for both uplink and downlink, and estimated that the maximum distance to be able to track KSLV-1 stably is dependent on uplink characteristic in our system.

A Study on the Prediction of the Base Flow Characteristics of a Launch Vehicle Using CFD

Younghoon Kim, Honam Ok, Insun Kim
Thermal & Aerodynamics Dept., KARI, Deajeon, 305-333, Korea

Numerical simulations are made to predict the axial force coefficients of a two-stage launch vehicle, and the results are compared with those by wind tunnel tests. It is found that the forebody axial force is not affected by whether the base of the body is modeled or not. Modeling the sting support used in wind tunnel tests reduced the base axial force compared to the results without it. The present calculation shows that the forebody axial forces are underestimated while the base axial forces are overestimated. The total axial force, therefore, compares with the experimental data with better accuracy by cancelling out the errors of opposite signs. Modeling of the sting support in numerical simulations is found to be necessary to get a better agreement with the experiments for both base and overall axial force coefficients.

A Study on Degreasing Detergent and Method for the IPP test facility

Yong-Wook Kim[1], Jung-Ho Lee[1], Sun-Il Kang[1],
Sang-Heon Kim[2] and Seung-Hyub Oh[1]

[1]Propulsion system Department of the Korea Space Launch Vehicle Program Office, Korea Aerospace Research Institute(KARI)

[2]R&D 7 Team of the Space Program Department, ROTEM research Institute

IPP(Integrated Power Plant) Test Facility will be constructed for the variety of tests on KSLV(Korea Space Launch Vehicle) Program in the Space Center. IPP test facility includes comprehensive test equipments for liquid rocket launch vehicle. Using this facility, KARI will verify the adaptiveness of parts and subsystems for launch vehicle and finally qualify the system characteristics of launch vehicle carrying out various tests including hot firing test. Liquid oxygen(LOx), kerosene, helium(He) and nitrogen(N_2) will be used for propellants and pressurizing fluids in this facility. Among them, LOx is a light blue, odorless, transparent liquid. Also it is not shock sensitive and does not decompose. However, it is a strong oxidizer and will vigorously support combustion. Therefore all harmful contaminants (such as grease, oil, fingerprint and organic materials) that could cause malfunctions, fires, or explosions in a oxygen environments must be completely removed prior to the introduction of oxygen. Especially, grease ingredient located inside of the LOx supply line, pipe and PHS (Pneumo-Hydraulic System) part can make drastic chemical reaction with oxygen. Therefore, to protect rapid reaction such as explosion, grease ingredient must be surely eliminated by a regular and irregular degreasing. Study on the availability, effectiveness and selection of degreasing detergents and method is described in this paper, and it will be useful for the construction and management of IPP test facility.

An Investigation on the Performance of a Propulsion System with the Branch Location of an Oxidizer Feeding Line

Ji Hoon Kim, Han Ju Lee, Dong Ho Jung, Yong Wook Kim and Seung Hyub Oh

Propulsion System Department, KSLV Program Office, Korea Aerospace Research Institute

For improving propulsion performance and efficiency of space launch system, decreasing mass of structure is so essential subject. Particularly, with clustering several engine systems, reducing the engine supporting area is necessary for high efficiency of propulsion system. In this article, for the propulsion system with the clustered engine system the investigation of propulsion performance according the branch location of oxidizer feeding pipe has performed with the mass of structure, pressure of oxidizer tank and two phase fluid generation in the oxidizer pipe. We consider the performance of the propulsion system in two cases. The first case is that the oxidizer feeding pipe is divided with 4 pipes under the fuel tank lower part and the second case is under the oxidizer tank lower part. The mass of the structure and the pressure for pressurizing the oxidizer tank are similar to each case. However, some supplementary structure preventing the onset of nucleation boiling in the oxidizer line may be required in the latter case.

Anaysis of Engine Starting Mode with a Pyro-Starter

Moon, Insang, Park, Soon-Young and Choi, Hwan-seok Choi
KARI (Korea Aerospace Research Institute), Engine Group

As a part of developing launch vehicle engine systems, characteristics of the engine starting mode was studied. The modeled engine system adopts an open cycle propellant feeding system with a coaxial turbine and a fuel/LOx pump started with a pyro-starter. The pyro-starter consists of casing, pyro-charger and some other devices. When the pyro-charger ignites, its combustion products starts the turbine, revolution speed of the impeller and finally some time later a gas generator. Since, the power generated by the turbine was consumed to pump the fuel and oxidizer, it is very subtle, to decide the time when the valves open. This study mainly focused on how the turbine evolved with the products from the pyro-starter and the dependancy of the revolution speed and propellant valve opening time.

Residual Propellant Gauging Method Using Thermal Pumping of Multi-tanks Satellite System

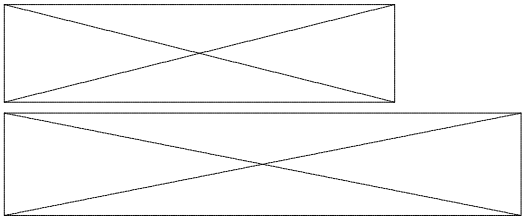
Park Eung Sik, Moon Gyung Nam
COMS(Communication, Ocean & Meteorological Satellite) Program Office, KARI

The residual propellant of satellite is the primary factor of satellite life. This propellant used in the satellite is stored as liquid in tanks. But it is very difficult to accurately measure propellant to be used for maintaining of satellite by an irregular influence of environment such as uncertainty of satellite thruster performance, solar wind pressure, magnetic fluctuation and so on. Additionally, it is also very difficult to gauge directly residual fuel in tanks because the propellant is spreaded over the tank by microgravity in the space. In spite of difficulty of propellant gauging, various methods for gauging residual propellant of satellite have been currently proposed and used in operation of satellites. The methods such as bookkeeping method, PVT method and thermal mass method are widely used. In this paper, a new method of gauging propellant residual of satellite employing multi-tank system by measuring mass flow of thermal pumping liquid propellant is presented. In cases of being connected between tanks, propellant in tanks move by temperature difference of tanks. If propellant mass flow is measured at line between tanks, residual propellant in tanks is able to be estimated.

Explicit Guidance Thrust Integrals Derivation for a Launch Vehicle With Varying Thrust

Eun-Jung Song and Woong-Rae Roh
Dept. of Guidance and Control, Korea Aerospace Research Institute

Most of closed-loop guidance algorithms for launch vehicles use constant thrust or constant acceleration thrust models to simplify the computation of thrust integrals. The thrust modeling errors, which can be induced by these assumptions especially for varying thrust case, have a significant effect on the orbit injection accuracy and optimality. In order to improve the estimation of these thrust integrals, Shina[1] modeled a non-uniform thrust as linearly varying either increasing or decreasing over limited time segments. The corresponding thrust integrals are developed in a simple way. An earlier developed algorithm is extended where each of these linearly varying thrust segments is considered equivalent to a stage of a multi-stage rocket. However the thrust integral values are more directly related with acceleration than with thrust as shown below.



In this study, thrust integrals using linear functions and nonlinear functions using neural networks which approximate acceleration profiles instead of thrust profile in Ref. [1] are derived. And the corresponding time-to-go prediction is evaluated. These thrust integrals can be used by most of explicit guidance algorithms and improve performance considerably with varying thrust. The numerical results show that the thrust integrals developed here provide significantly more accurate results than constant/linear thrust models or constant acceleration models.

[1] S.K.Shina and S.K.Shrivastava, Explicit guidance of a rocket with non-uniform thrust, *Acta Astronautica*, No. 6/7, pp.555-560, 1989.

Design and Functional test of On-board Flight Analog Video System

Sang-Rae Lee, Sung-Wan Kim and Jae-Deuk Lee
Electronics Dept., KSLV Technology Division, KARI, Daejeon, 305-333, Korea
E-mail: sanglee@kari.re.kr

Various telemetry products are used to gather and process critical information on-board launch vehicles. Data is transmitted by RF links to fixed or mobile receiving stations. This paper discusses the design and functional tests of video telemetry system as a means of providing launch vehicle performance data. Adopted analog video transmission technique, the system is so simpler architecture and test than digital video compression system. The parts of on-board analog video system are composed of two cameras, video control unit, video transmitter, power divider and antennas. Video control unit and video transmitter have been designed, implemented in prototype model and tested functionally. As results of functional tests, we have made the verification and validation that the switching operation was performed in time according to the flight key events, and frequency modulation and demodulation of NTSC color signals were executed with pre-emphasis and de-emphasis processing successfully.

An Analytical Study on the Dynamic Characteristics of a Liquid Propulsion System

Han Ju Lee, Seok Hee Lim, Dong Ho Jung, Yong Wook Kim, and Seung Hyub Oh

Propulsion System Department, KSLV Program Office, Korea Aerospace Research Institute

The longitudinal instability (POGO) of a rocket should not be occurred during the whole flight time for the large class liquid propulsion system to complete a mission successfully. The longitudinal instability is caused by the resonance between the propulsion system and rocket structure in the low frequency range below 50Hz, ordinarily. Analysis on the low frequency dynamic characteristics on the liquid propulsion system with staged combustion cycle engine system was performed as a preliminary study on the longitudinal instability analysis. The frequency responses such as ☒, ☒, ☒, ☒, ☒, and ☒ show that the main characteristics which may exert some action on the rocket longitudinal stability are ☒ and ☒, that is, the dynamic characteristics in the oxidizer line.

Shock Wave Boundary Layer Interaction Studies In Corner Flows

Hee-Joon Lee[1], Jan B. Vos[2]
[1]Control Systems Group, Korea Aerospace Research Institute, Daejeon, 305-333, Korea
[2]Department of Mechanical Engineering, Ecole Polytechnique Federale de Lausanne, Lausanne, CH1015, Switzerland

Shock wave boundary layer interactions can make flows around a vehicle be very high pressure and temperature due to pass shock waves in small areas of the hypersonic vehicle. These phenomena can affect a critical problem in the design of hypersonic vehicles. To research the effect of shock wave boundary layer interactions, corner flows were studied in this paper using numerical studies with the NSMB(Navier-Stokes Multi Block) solver and then comparing corresponding numerical results with experimental data of the Huston High Speed Flow Field Workshop II. The mach number of flows is 12.3 in corner flows. The comparison with the computational result is presented based on diverse numerical schemes. Good agreement is obtained.

An analysis of thrust and specific impulse of the Liquid Rocket Engine according to the change of chamber pressure and the flight height

Seok-Hee Lim, Young-Suk Jung, Kie-Joo Cho,
Gyu-Sik Cho, Seung-Hyub Oh
Propulsion System Dept. KARI

Thrust and specific impulse which are required from the rocket design are the most important parameters for the propulsion system design. These parameters depend on the chamber pressure and the flight height(ambiance pressure). Each of them are called the mass flow rate characteristic and the height characteristic. The analysis of these thrust and specific impulse according to the chamber pressure and the flight height make us understand the physical characteristics and the design of liquid rocket engine(LRE). This study shows the mass flow rate characteristics and the height characteristics for the concrete 170ton class LRE using UDMH and Liquid Oxygen.

The Variation of System by Density-Drop of Propellants in LRE

Young-Suk Jung, Kie-Joo Cho, Gyu-Sik Cho,
Seok-Hee Lim, Seung-Hyub Oh
Propulsion System Department, KARI, Daejeon, 305-333, Korea
E-mail: ysjung@kari.re.kr

The characteristic of turbopump system of liquid rocket engine is decided by the correlation of turbopump, combustion chamber and gas generator characterized by the flowrate of propellants and the rotation speed of rotor. In launch vehicle has such features, the propellant is heated from aerodynamic heating and contacting with pressurization gas on high temperature, its density becomes low. Because of that, the balance condition(volume flowrate, mass flowrate, pressure etc) of LRE on steady state changes and the thrust of LRE decreases in case of system that uses only the orifice without active control parts(control valve). In this paper, it was studied that how the density-drop of propellant leads to the decrease of its volume or mass flowrate and the thrust of LRE.

The dynamic analysis of a thruster system in a satellite launch vehicle

Taekyu Jung, Joongyup Lee, Sangyup Han, Youngmok Kim
Korea Aerospace Research Institute

Thruster systems are used to control of the attitude of satellite launch vehicles or satellites. The thrust of thruster is controlled by means of the control valve in the thruster system. When the control valve operate, so called water hammering phenomenon can break out. The system working pressure can be increased highly due to the water hammering effect and the system can fail because of the high pressure over the design pressure. Therefore the prediction of water hammering effect by means of computer simulation is inevitable to design a reliable thruster system. This article deal with simulation method and compare the test and simulation results. By use of the method that can treat the frequency dependent friction, the test and simulation results shows a good coincidence.

Tank Depletion System for Space Launch Vehicle

Kie-Joo Cho, Young-Suk Jung, Gyu-Sik Cho and Seung-Huyb Oh

Propulsion System Department, KARI, Daejon, 305-333, Korea

It was considered that the necessity and roles of closed loop control logic based tank depletion system for bi-propellant liquid rocket propulsion system. To maximize the total impulse generated by propulsion system, the tank depletion system which makes both propellant tanks run dry simultaneously is necessary. And from the facts that there are many uncertain factor affecting to the propellant usage during launch preparation, powered flight and coasting mission, it was concluded that the closed loop control logic should be applied to tank depletion system to satisfy the requirement of total impulse accuracy requirement from space launch vehicle.

Introduction of the Program Life-cycle Management System for Space Launch Vehicle Development

Miok Joh, Young-In Choi, Kyoun-Su Seo, Bum-Seok Oh[1] and Gwang-Rae Cho[2]

[1]System Engineering Management Department, Korea Aerospace Research Institute

[2]KSLV Program Office, Korea Aerospace Research Institute

Tailored system engineering is being performed in research and development of Korea Space Launch Vehicle(KSLV) system to ensure that concurrent engineering is properly applied through the program life-cycle by involving the required specialty engineering disciplines. A web-based program life-cycle management system is introduced to implement the system engineering processes and to provide the development traceability online. This information system aims for the realization of essential system engineering management techniques currently applied to the KSLV program including management of configuration and data based on the work breakdown structure(WBS), WBS, bill of materials and mass properties management. Drawings and computer-aided design(CAD) models can be reviewed and approved online through bidirectional, realtime interaction with the standardized CAD system. The system enhances communication and gives access to the development data with relevant information such as data-to-data relation and approval status/history through the web, and preserve all of the development data throughout the program life-cycle. Further improvement of the system is planned to implement the program management processes and to provide integrated information useful for the programmatic decision making.

Reliability Demonstration of Propulsion System of Space Launch Vehicle

Yong-Wook Kim[1], Sang-Yeon Cho[1], Seung Hyub Oh[1] and Chan-Bin Park[2]

[1]Propulsion System Dept, Korea Aerospace Research Institute
[2]Engineering Management Dept, Korea Aerospace Research Institute

In executing the large scale national project, such as development of space launch vehicle, it is most important to guarantee the technological reliability. However the reliability analysis of launch vehicle is different from other mass product goods because of the limitation of budget and number of tests. In this study, the reliability analysis technique of the propulsion system, which is one of the major sub-systems of launch vehicle is illustrated and applied to the liquid rocket engine of KSR-III.

Ascent Thermal Analysis of Fairing of Space Launch Vehicle

Sang-Ho Choi, Seong-Lyong Kim, Insun Kim
Dept. of Thermal/Aerodynamics, Korea Aerospace Research Institute

The fairing of the launch vehicles has a role of protecting the spacecraft from outer thermal, acoustical, and mechanical loads during flight. Among them, the thermal load is analyzed in the present study. The ascent thermal analyses include aerodynamic heating rate on every point of the fairing, heat transfer through the fairing and spacecraft, and the final temperature during ascent flight phase. A design code based on theoretical/experimental database is applied to calculate the aerodynamic heating rate, and a thermal math program, SINDA/Fluint, is considered for conductive heat transfer of the fairing. The results show that the present design satisfies the allowing temperature of the structure. Another important thermal problem, pyro explosive fairing separation device, is calculated because the pyro system is very sensitive to the temperature. The results also satisfies the pyro thermal condition.

Prelaunch Thermal Analysis of KSLV-I Payload Fairing

Sang-Ho Choi, Seong-Lyong Kim and Insun Kim
Thermal & Aerodynamics Department, Korea Aerospace Research Institute, Daejeon, 305-333, Korea
E-mail: sahchoi@kari.re.kr

Prelaunch thermal analysis of the KSLV(Korea Space Launch Vehicle)-I PLF(Payload Fairing) was performed to predict maximum/minimum liftoff temperatures and to evaluate of air conditioning performance. Prelaunch thermal analysis includes internal air conditioning effect, external convective heating/cooling, radiation exchange with the ground and sky, radiation between spacecraft and PLF, and solar radiation incident on PLF. Analysis was performed at two extreme conditions, hot day condition and cold day condition. The results showed that the maximum liftoff temperature was 53℃ and the minimum liftoff temperature was -3.8℃. It was also found that conditioned air supplying, in 20±2℃ and 1200 m^3/hr, is sufficient to keep the internal air in required temperature range.

Development of Thermal Control System for Cryogenic Environment of Launch Vehicle

SangYeop Han, Seong-Up Ha, Byung-Hoon Kim, Young-Mog Kim

Control Systems Department, Korea Aerospace Research Institute

To provide normal operational thermal condition for instruments and components installed near and under feeding lines and storage tanks of cryogenic fluid in a liquid-propellant launch vehicle, a thermal control system using a cryogenic insulator and a nitrogen gas purge has been developed. This study is carried out to develop an optimized thermal control system, which satisfies the launch vehicle system requirements of weight, performance, and geometric limitation, by observing thermal control effects using the above-mentioned insulation system and purge system experimentally. In this study, cryogenic source was generated from a liquid nitrogen, which was stored in an aluminium (AL-2219) cased tank. Experiments were undertaken to find out control effects on conductive heat transfer only as well as on both conductive and convective heat transfer. The results show that a cryogenic insulator is having the heat conduction control effect of about 114℃~130℃ while a nitrogen gas purge brings the additional heat convective control effect of about 16℃~45℃. With the results of this study, it was possible to design and develop an optimized thermal control system for cryogenic environment, which can be applicable to a liquid-propellant launch vehicle.

Current Status of STSAT1 satellite by on-Orbit Log Information

Kyung-In Kang, Geun-Soo Shin, Hong-Young Park,
Kyung-Hee Kim, Jong-Joo Lee, Sae-Il Kim, Jong-Tae Lim
Satellite Technology Research Center, KAIST

In order to obtain a clear understanding on the status of STSAT1 satellite in orbit, we have downloaded and analyzed the whole telemetries of the satellite since Sep. 28 2003 after launched it. In case of the sun-synchronous satellite, one of important telemetries is battery condition to operate in eclipse which is depending on operation mode of attitude control system. This paper describes operation log of the battery voltage and charge/discharge current. And we see the temperature of satellite also to understand more clearly the attitude of satellite. There are also some analyzed information of single event upsets(SEU) in on-board computer(OBC) by space high energy particles. During one year, the STSAT1 has been operated the mission well in orbit except one problem with update of Attitude Determination Control System(ADCS) software recently. But the battery condition looks more good than that of just before this problem happened. So, we hope that the STSAT1 will be operated well more than the mission life, 2 years.

The Implementation Method and Test of Telemetry Trend Analysis in KOMPSAT-2

Myungja Kim, Won-Chan Jung, Jae-Hoon Kim
Satellite Ground Control Team, ETRI, Daejeon, 305-350, Korea
E-mail: myungja@etri.re.kr

In this paper, we will present the implementation method of telemetry trend analysis in KOMPSAT-2(KOrea Multi Purpose SATellite II), and then we will show the test result of trend analysis with telemetry data. Trend Analysis function is one of the module of Satellite Operations Subsystem and that analyzes the telemetry data of satellite state of health and telemetry trend for operation support. With this system many clients can analyze telemetry data simultaneously.

Error Analysis of SEE qualification for MPC860 Microprocessor

Sung-Joon Kim[1], Jongho Seon[2], Kyoung-Wook Min[1],
Wonho Choe[1], Dai-ho Ko[1]
[1]Department of Physics, KAIST
[2]SaTReCi Co. Ltd.

Various space radiation environments have effects on electronics in all artificial satellites and spacecrafts. Especially single event effect (SEE) by high energy charged particles in space is as critical as it can make the satellite system bring to a halt. SEE test and rate prediction are necessary for accomplishment of space mission. This research investigates how the error of main parameters appeared in the process of SEE qualification for microelectronics affects SEE rate prediction. Based on the test results of Motorolla MPC860 microprocessor adopted as On Board Computer of MACSAT being developed by SaTReCi, the effect by the errors of threshold energy and saturated cross section are analyzed. Orbit dependence of these parameters is also considered.

A Proposed High Availability Architecture for Coms Ground Control System

In-Jun Kim, Jae-Hoon Kim
Communications Satellite Development Group, ETRI, Daejeon, 305-350, Korea
E-mail: ijkim@etri.re.kr

A satellite ground control system(SGCS) which monitors and controls a geostationary satellite 24 hours a day has to achieve the system architecture assuring high-level availability and redundancy scheme. The SGCS for Communication, Ocean, and Meteorological Satellite(COMS) is currently being developed in Korea, which will be implemented to satisfy high availability(HA), expansibility, and compatibility in design. In order to implement the system architecture to meet these characteristics, the SGCS for COMS introduces the concept of the real-time distributed system structure based on redundancy scheme for high availability,

Efficient Thermal Modeling In Development of a Spaceborne Electronic Equipment

Jung-Hoon Kim and Ja-Chun Koo
Communication Satellite Systems Department,
Korea Aerospace Research Institute, Daejeon, 305-333, Korea
E-mail: jungkim@kari.re.kr

The initial thermal analysis needs to be fast and efficient to reduce the feedback time for the optimal electronic equipment designing. In this study, a thermal model is developed by using power consumption measurement values of each functional breadboard, that is, semi-empirical power dissipation method. In modeling heat dissipated EEE parts, power dissipation is imposed evenly on the EEE part footprint area which is projected to the printed circuit board, and is called surface heat model. The application of these methods is performed in the development of a command and telemetry unit (CTU) for a geostationary satellite. Finally, the thermal cycling test is performed to verify the applied thermal analysis methods.

Design and Implementation of Telemetry Interface for KSLV-I

Joonyun Kim[1] and Bo-Gwan Kim[2]
[1]Electronics Dept., KARI, Daejon, 305-700, Korea
[2]Dept. of Electronics Engr., Chungnam Nat'l Univ., Daejon, 305-764, Korea
E-mail: jnkim@kari.re.kr

KSLV(Korea Space Launch Vehicle)-I telemetry system will be composed of two telemetry streams, lower stage telemetry stream and upper stage telemetry stream. The telemetry processing unit, a key part of upper stage telemetry system of KSLV-I, interfaces with remote data unit and control system units via MIL-STD-1553B data bus. And it interfaces with payload(KoDSat) and the ground equipment via RS-422 link. In order to interface with payload, a UART(Universal Asynchronous Receiver Transmitter) has been designed and implemented with Xilinx FPGA which is coded by Verilog HDL(Hardware Description Language). Double buffered memory has been employed in PCM(Pulse Code Modulation) generator interface to output PCM data. The telemetry processing unit MDU has been designed to include two MIL-STD-1553B communication chains to collects environmental telemetry data from other telemetry subunits and health monitoring data from other subsystems. Chain 1 interfaces with a remote data unit and a shock recorder unit and chain 2 interfaces with onboard control units (e.g., Navigation Guidance Unit, Thruster Driving Unit, and so on). This paper describes design, implementation and test of upper stage telemetry interface for KSLV-I. The telemetry processing unit is in the prototype model at present and its engineering model and flight model will be developed in the near future.

K-2 Bus Platform Evaluation Based on The Analysis of RF System Characteristics

Tae-Youn Kim, Byung-Hee Min, Seong-Bin Lim and Seok-Won Choi

Space Test Group, Korea Aerospace Research Institute, Daejeon, 305-600, Korea

Satellite system and equipment operates in a complex electromagnetic environment made up of electronic, electrical power system, and RF transmission system. The KOMPSAT-2 satellite has a S-band communication system for command and data handling and X-band transmission system for payload data. In addition, X-band system has high gain directional antenna whose directional beam has to pass over the K-2 system. The energy generated by RF transmitter can be radiated into the surrounding environment and it may adversely affect the operation of satellite system. The electromagnetic radiation incident upon the system or equipment surface couples through apertures into the system interior and the internal EM fields induce RF voltage on the system interconnecting cables. The induced RF voltage can be rectified by the internal devices, and offset voltage and currents may be produced that are large enough to upset the operation of the electronic circuits. So the electromagnetic environment should be considered that is one of important design parameter in system development stage because it could caused a tremendous effect of system performance on orbit or shorten a life of satellite. In this paper, electric field radiation which impact on equipment and systems operation by the RF antenna system of KOMPSAT-2 has been calculated and it is used for ensuring of K-2 system operation under the those environment. The radiated susceptibility testing should be performed to demonstrate through test, that the satellite system will neither malfunction nor experience degraded. As a results, it is evaluated that K-2 bus system is normally operated with a high field intensity electromagnetic environment.

Bus System Evaluation by Conduction Noise Injection

Tae-Youn Kim, Seong-Bin Lim and Seok-Won Choi
Space Test Group, Korea Aerospace Research Institute, Daejeon, 305-600, Korea

The electronic device or electrical power systems of satellite are often the most serious sources of conducted interference. The energy generated by power system can be conducted from the source into other equipment and systems via power leads, signal leads, externally connected leads and interconnecting cables. This conducted noise should be caused problems in potentially susceptible devices either directly or through a common ground. For this reason, it is necessary to control the conducted noise in the electrical system and to evaluate the conducted susceptibility at the given environment. The purpose of the conducted susceptibility tests is to ensure that the equipments or systems will not cause performance degradation or malfunction in a simulated conducted noise environment. In this paper, the function of KOMPSAT-2 bus system is evaluated on the conducted coupling environment without any degradation and malfunction through the immunity test. For K-2 system level, test limits are determined by the self generated emission level in consideration of system EMC margin.

Calibration of Image Geolocation by Thermal Distortion Map

Hee-Seob Kim, Eyunhyun Kim, Bum-Seok Hyun
Korea Aerospace Research Institute, Daejeon, 305-600, Korea
E-mail: ekim@kari.re.kr

Thermal distortion degrades the accuracy of satellite image position. For minimizing geolocation error between real location and estimated location obtained using satellite attitude and orbit information, thermal distortion must be compensated. Main idea of this paper is that thermal effects have periodical characteristics when satellite orbit is sun-synchronous and satellite operation is periodic and satellite does not maneuver during earth observation period. In order to compensate the thermal effect, 2 dimensional thermal distortion map is proposed in this paper. For validation of the proposed method, we show that thermal distortion is function of orbit angle for simplified satellite model and scenario.

The Conceptual Design of a Power Control and Distribution Unit for the Next Generation Satellite

Sung-Woo Park, Jin-Baek Jang,Hee-Sung Park, Sung-Soo Jang, and Jong-In Lee

[1]Korea Aerospace Research Institute

The Power Control and Distribution Unit(PCDU) has roles of protection of battery against overcharge by active control of solar array generated power, distribution of unregulated electrical power via controlled outlets to bus and instrument units, distribution of regulated electrical power to selected bus and instrument units, and provision of status monitering and telecommand interface allowing the system and ground operate the power system, evaluate its performance and initiate appropriate countermeasures in case of abnormal conditions. In this work, we design the functional schemes of a PCDU for the next generation satellite conceptually. The main constitutes of the PCDU are the battery interface module, the auxiliary supply modules, six solar array regulators with maximum power point tracking(MPPT) technology, two heater power distribution modules, three spacecraft unit power distribution modules, and one instrument power distribution module.

Design of a Scalable Power Bus Regulator for PCDU of Satellites

Sung-Woo Park[1], Jong-Duck Kim[2], Hee-Sung Park[1],
Jin-Baek Jang[1], Sung-Soo Jang[1]
[1]Korea Aerospace Research Institute, [2]Korea Aerospace Industry

For the generation of the regulated or unregulated bus system from solar array generated power, we usually use power bus regulators. And whenever we design a new power system of satellite, it is needed for us to redesign or modify of the previously designed and used power regulators due to the difference of their power capability. But it requires much time and effort to change the power capacity of previous versions. Therefore in this paper, we propose a more simple and cost-effective approach to design bus regulators and then increase their rating easily. The bus regulators are operated in parallel and controlled by a triple set of main error amplifiers with majority voting. And the phase difference of each modules are automatically set by the phase synchronous controller to minimize the output ripple voltage.

The MPPT Design for Small Satellite in LEO

Hee-Sung Park, Sung-Soo Jang, Sung-Woo Park,
Jin-Beak Jang and Jong-In Lee
Satellite Electronics Dept. of Satellite Technology Division,
Korea Aerospace Research Institute
E-mail : hspark74@kari.re.kr

The SAR(Solar Array Regulator) of KOMPSAT(KOrea Multi Purpose SATellite)-1, 2 regulates a photovoltaic power according to the duty ratio commands of the ECU. But the ECU has so many other jobs that it can not calculate the solar array condition immediately. It means the SAR cannot always generate the maximum power of a photovoltaic. Nowadays, the commercial photovoltaic systems are using a controller operated by digital processing. But the usage for satellite is not adaptable. It is not easy to find the processor of the space grade and the price is expensive. So in this paper, the simple analog MPPT(Maximum Power Point Tracking) algorithm is proposed for the small satellite in LEO. This algorithm does not need any calculation of power by multiplication of voltage and current and a measurement of the solar array temperature. It is consist of only two sample and hold circuits, two comparators, a flip-flop, and an integrator. The proposed MPPT algorithm is verified by the simulation and experimental.

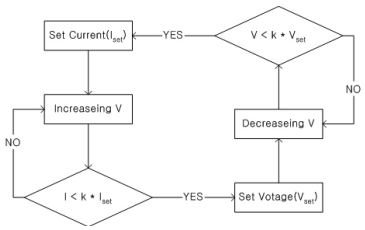


Fig. 1 Flow of MPPT Control

Unit Modeling for Conducted Emission Noise Analysis of a Satellite System

Na-Young Lee, Jin-Ho Lee, Sang-Ryool Lee and Joo-Jin Lee
[1]KOMPSAT2 System & Integration Department KOMPSAT Program Office, Korea Aerospace Reserch Institute, Daejeon, 305-333, Korea

In the satellite design that consists of many different electrical units, it is important to define and establish the electromagnetic environment for the normal operation of each electrical unit. If one unit has stronger electromagnetic field radiation than the limit or causes more noise in interface lines than the level other units can tolerate, eventually there will be abnormal operation of certain unit or gradual degradation in the performance. From the conducted emission (CE) test results of the SAR, the CE level has a high level at the 94kHz. This is the switching frequency and it is necessary to analyze the effect of this CE level to another satellite unit and a satellite system. To do this, the model of the SAR output filter and the cable between the SAR and PCU are presented. When the noise, which is same with the test condition, is injected to the model, the output noise scale is compared with the test result. From this comparison, it seems reasonable to use the presented SAR model and the cable model to analyze the CE noise of the satellite system.

The Analysis on Space Radiation Environment of STSAT-2

Seung-Hun Lee and Eun-Sup Sim
Science and Technology Satellite Group, Korea Aerospace Research Institute

In this paper, space radiation environment and its two effects (Total ionizing dose (TID) effect and single event effect (SEE)) have been analyzed for Science and Technology Satellite-2 (STSAT-2) operational orbit. Trapped protons and electrons, and solar protons are considered as major factors affecting TID. From the analysis results, low energy particles can be blocked by increasing aluminum shielding thickness but high energy particles cannot be blocked effectively by increasing aluminum shielding thickness. For analysis on SEE, trapped proton, solar energetic particle (SEP) and galactic cosmic ray (GCR) high energy protons and heavy ion are major factors affecting SEE. The spectrums of these factors are analyzed

A Comparison of Thermal Math Modelings for Power Cable in Space Environment Simulation

Jang-Joon Lee, Hui-Kyung Kim, Bum-Seok Hyun and Joon-Min Choi
Satellite Core Technology Department
Korea Aerospace Research Institute, Daejon, Korea, 305-600

To simulate space thermal environment for satellite development on ground, thermal vacuum chambers are commonly used. In thermal vacuum chambers, not only cryogenic cold environment but also heat fluxes from outer space to a satellite are simulated. One of the techniques which simulate heat fluxes, which are direct solar energy, reflected solar energy from earth, and infrared energy from earth is using heaters. In this method, heaters are directly attached on the satellite's heat exchanging area and the calculated equivalent energy is applied on that area. In the thermal vacuum test by this method, many heaters are used for the test and power cables which supply the electric power to the heaters are also used. Every test objective and supporting equipment must be protected within their allowed temperature range to avoid failure. The power cables require thermal analysis because it generate a huge heating power which cause great temperature rise during a thermal vacuum test while electric currents flow and this may cause failure. In case of no electric currents, the power cable also require thermal analysis because it must be protected from cryogenic cold environment using by means of thermal insulation. Thermal modeling of power cable was performed in various methods. Three different design variables were considered in thermal modeling. They were a size of gap between cables, a value of surface emissivity of the cable and a size of cross section area of the cable. Different values of each variable were applied to developed thermal model of cables and results were obtained from several test cases. Analyses were performed from these results to find out which variable is the most critical factor to determine the temperature range of power cables.

Ka-band Antenna Performance Analysis of COMS Satellite

Jeom-Hun Lee, Jang-Sup Choi, Seong Pal Lee
Communications Satellite Development Group, ETRI

This paper describes Ka-band antenna performance analysis of COMS satellite. The key parameters of the antenna system are optimal antenna diameter, feed horn type and horn size, F/D, and the coordinate of offset horns. The paper deals with the method to determine design core parameters of optimal antenna diameter, feed horn type and horn size, F/D, and the coordinate of offset horns, and the performances of design result.

A Position Tracking Algorithm with Radar Measurement

You-Chol Lim, Keun-Soo Ma and Jae-Deuk Lee
Electronics Department of KSLV Division, KARI, Daejeon, 305-333, Korea

Position and trajectory data of in-flight vehicle are important information to determine flight safety of vehicle. In general tracking system, radar and transponder are used to acquire position information. Vehicle position and trajectory can be determined by RF communication between radar ground station and in-flight rocket, and antenna position data. The radar ground station within range of the vehicle can interrogate the vehicle transponder continuously using a synchronized rapid sequential time-sharing technique. The round-trip transit time of the pulsed signal is measured and used by the radar computer to determine the range of the vehicle. The elevation and azimuth angles of the returning signal are transferred to the radar computers and recorders directly from elevation and azimuth shaft encoders to determine vehicle location. This paper describes the remote tracking algorithm using measurements (azimuth, elevation, and slant range) of the radar ground station. Kalman filter model for noise reduction of the measured information is first derived by linearizing with respect to angle, angular rate, range, and range rate. And then a tracking algorithm is introduced to calculate the position of the vehicle during in-flight. The simulation results show that the algorithm is practical and effective enough tracking position of the vehicle in considerably less error.

Satellite Operation Plan at Launch Site for Launch Preparation

Jeong-Heum Im, Sang-Kon Lee and Sang-Ryool Lee
[1]Dept. of Systems Engineering and Integration, Korea Aerospace Research Institute

This paper described a satellite operation plan to be performed at a launch site in preparation for the launch of a low-earth orbit small satellite. The plan covers the period from the arrival of the satellite and its ground support equipment at the payload processing facility of the launch site till launch. To accomplish the plan objectives, it takes about 40 working days. The operation consists of post-ship satellite inspection, functional checkout, satellite mating with launch vehicle payload adapter, mechanical/electrical interface checkout test between satellite and launch vehicle, launch rehearsal and actual launch campaign. Satellite transportation configuration, flight battery charge requirements, satellite fuelling constraints and launch site safety requirements influence on the overall satellite operation sequence.

Front End Telemetry Data Acquisition Unit for KSLV-I Upper Stage

Hae-Seung Jung, Joonyun Kim, Jae-Deuk Lee
Electronics group, KSLV Technology Division, KARI, Daejon, 305-333, Korea
E-mail: hsjung@kari.re.kr

Upper stage telemetry system of KSLV-I (Korea Space Launch Vehicle I) is composed of MDU(Master Data Unit), RDU(Remote Data Unit), SRU(Shock Recorder Unit) and Transmitter. RDU is the front-end telemetry data acquisition unit which gathers analog/discrete signals from various sensors and other units, and transmits the processed data to MDU via MIL-STD-1553B data bus. In order to acquire useful data from analog signal, signal conditioning circuits, such as anti-aliasing or amplifying, should be implemented. For this purpose, SCM(Signal Conditioning Module) had been developed. This paper describes hardware structure of SCM and analog signal conditioning circuits for various sensors. Also, sampling time scheme for different sampling rates were designed and tested.

KOMPSAT-2 RF Compatibility Test for S-Band

Seung-Won Cho, Young-Su Youn, Jong-Yeon Choi, Seok-Weon Choi
Korea Aerospace Research Institute (KARI)

KOMPSAT-2(Korea Multi Purpose Satellite 2) which is scheduled to launch in 2005 year will communicate with KARI TTC(Tracking, Telemetry, and Command) station flying along sun synchronous orbits(685km). The command from KARI TTC pass S-band omni-antenna, RF assembly, and transponder and finally reach OBC (On Board Computer). The telemetry from KOMPSAT-2 arrive at KARI TTC through inverse procedure. In this paper, RF compatibility test between KOMPSAT-2 and KARI TTC station is demonstrated . RF interface for this test was established through real space and uplink signal test and downlink signal test and uplink & downlink signal test were performed.

A Study on Thermally Induced Dynamics of the Geostationary Satellite with a Single Solar Array

Gwanghyeok Ju, Hyoung Yoll Jun, Koon-Ho Yang
COMS Program Office, Korea Aerospace Research Institute

In the geosynchronous orbit, the solar pressure is the primary source of environmental attitude disturbance on the geostationary satellite. The solar radiation pressure forces and torques are due to photons impinging on a surface in space. Additional attitude disturbances also result from thermally induced deformations of deployable appendages. Nonuniform thermal loading may give rise to cross-sectional temperature differences in appendages which, due to differential thermal expansion, result in thermoelastic deformations. Additionally, thermally induced structural disturbances are typically initiated during orbital eclipse transitions when a spacecraft exits from or enters into the Earth's shadow resulting in rapid changes in thermal loading. Thus, motions of flexible appendages such as deployable booms and solar arrays result in disturbance torques reacting on the main body of the spacecraft and may have a significant effect on the attitude dynamics and control of the spacecraft. In this paper, the effects of thermally induced structural disturbances of a solar array on the attitude dynamics of the geostationary spacecraft are investigated based on the analytically driven dynamic model of the geostationary satellite with a single solar array.

A Comparison Study of Space Radiation Dose Analysis Programs: SPENVIS Sectoring Tool and SIGMA II

Jongwon Chae
Communication Satellite Systems Dept., KARI, Daejeon, 305-333, Korea
E-mail: firstbel@kari.re.kr

A space radiation analysis has been used to evaluate an ability of electronic equipment boxes or spacecrafts to endure various radiation effects, so it helps design thicknesses of structure and allocate components to meet the radiation requirements. A comparison study of space radiation dose analysis programs SPENVIS (SPace ENVironment Information System) Sectoring Tool and SIGMA II is conducted through some structure cases, simple sphere shell, box and representative satellite configurations. The results and a discussion of comparison will be given. A general comparison will be shown for understanding those programs. The both programs use the same strategy, solid angle sectoring with ray-tracing method to produce an approximate dose at points in representative simple and complex models of spacecraft structures. Also the particle environment data corresponding to mission specification and radiation transport data are used as input data. But there are distinctions between them. The specification of geometry model and its input scheme, the assignment of dose point and the numbers, the prerequisite programs and ways of representing results will be discussed. SPENVIS Sectoring Tool is currently web-operated for sectoring analysis for complex geometries. It may be useful for a preliminary dose assessment with user-friendly interfaces and a package approach. SIGMA II is able to obtain from RSICC (Radiation Safety Information Computational Center) as a FORTRAN 77 source code. It may be suitable for either parametric preliminary design or detailed final design, e.g. a manned flight or radiation-sensitive component configuration design. It needs some debugs, recompiling and a tedious work to make geometrical quadric surfaces for actual spacecraft configuration, and has poor documentation. It is recommend to vist RSICC homepage and GEANT4/SSAT homepage.

Design of Common EGSE & EGOE System for Satellite Test & Mission Control Element

Yong-Sik Chun [1], Sang-Kon Lee[1], Sung-Woong Ra[2]

[1]System Engineering & Integration Department, KARI, Daejeon, 305-333, Korea

[2]Dept. of Electronics Engineering, Chungnam National University, Daejeon, 305-764, Korea

e-mail: sik@kari.re.kr

The first satellite of Korea Multi-Purpose Satellite (KOMPSAT-1) was launched on 21 December 1999 by Taurus rocket in VAFB. The second satellite of KOMPSAT has been development by KARI. During the satellite development phase, dedicated satellite test sets which is Electrical Ground Support Equipment(EGSE) have been conducted to verify the satellite functionality and performance. The EGSE typically is a part of space segment used in various stage of the satellite development, integration/test & launch while Electrical Ground Operation Equipment(EGOE) typically is a part of ground segment used in operation of the satellite. The S/W and database backbone for EGOE is also commonly referred to as Mission Control System(MCS). Also many application and implementation overlaps between EGSE and EGOE, it is common to observe independent development of these equipment and ending up performing compatibility tests to eliminate the differences toward the tail phase of the I&T program prior to launch. This paper intends to look at this study from another respect to focus in the feasibility of the sharing the front-end interface portion of satellite test system, ground station & image processing unit. Also this paper is to identify feasibility of developing common equipment to be shared to minimize unnecessary effort during development and same equipment to support the span of satellite lifetime from test bed verification to the operation and data processing.

Environmental Test of the EQM Payload System for the Communications and Broadcasting Satellite

Jang Sup Choi, Jong Heung Park, Jong Won Eun,
Seong Pal Lee
Communications Satellite Research Group, ETRI

ETRI has developed the EQM(Engineering Qualification model) payload system for the communications and broadcasting satellite(CBS) with Korean local companies. This paper describes a series of environmental tests such as vibration, thermal/thermal vacuum, and EMC tests. All the development processes including the design, implementation, integration and workmanship were verified and evaluated by these tests. The results of the functional tests and the compliance to the requirements are also presented. The technologies and heritage obtained from this development will be applied to the development of the payload system for the Korean communication satellite in the near future.

The Design of System Software - EXEcutive CSC for KOMPSAT-2

Jong-Wook Choi, Jae-Seung Lee
Satellite Electronics Department, KOMPSAT Program Office,
Korea Aerospace Research Institute

The flight software of KOMPSAT-2 is consist of many different CSC (Computer Software Component) such as EXE/AOCS/TCS/EPS/CCI/ /DAQ/UTL CSCs and theses CSCs are controlled by Real-Time Operating System, VRTX. The flight software for KOMPSAT-2 should ensure a high reliability and safety and support normal operation without the contact from ground station. EXE CSC of KOMPSAT-2 is a essential and basic system software and it provides the processor's boot-up and initialization procedures, 3-processor's synchronization, task management, task scheduling, background operation and satellite health monitoring. In this paper, we present the roles and design concept of EXE module. Also we present the analysis of task scheduling, and throughput and timing measurement for KOMSPAT-2.

Comparison of Numerical Prediction with Test Results at Space Thermal Simulation Test

Hui-Kyung Kim, Bum-Seok Hyun, Jang-Joon Lee, and Joon-Min Choi
Satellite Core Technology Group. Korea Aerospace Research Institute, Daejeon, 305-333, Korea
E-mail: harry@kari.re.kr

Space thermal simulation test is conducted to verify thermal design of satellite and performance of electrical components. For this purpose, thermal vacuum chamber is utilized on the ground and it should have the capabilities to simulate the worst space thermal environments. After this test, the temperature data is compared with the numerically predicted data to tune the thermal math model, which will be used as a reliable tool to predict satellite temperature in orbit. In this study, the numerical prediction is used not only for the math model validity check after the test but also for test plan and preparation before the test. For this purpose, the unsteady thermal analysis for "Transition to Cold" stage with on/off behaviors of flight heaters is focused and compared with test results. These analysis results are also used to provide information of critical boxes which should be monitored by test operators with attention and protected by applying environmental heaters during transition to cold stage of thermal vacuum test.

Thermal Design on Satellite Payload Fixture for Space Simulation Ground Test

Jang-Joon Lee, Bum-Seok Hyun, Hui-Kyung Kim, and Joon-Min Choi

Satellite Core Technology Department,
Korea Aerospace Research Institute

In order to develop a satellite efficiently, the satellite design usually calls for the modular type configuration. The benefit of modular type is that the design, manufacturing, assembly and test of each module can be performed independently. In modular configuration, satellite consists of payload, electrical and propulsion module. Even though one of these modules is not available, the space simulation test can be performed without great difficulties or risks. The test objective considered in this paper is a satellite without payload module. The module is temporarily replaced by payload fixture (aluminum plate). The fixture accommodates the S-band antenna, sensors (star, sun, three-axis magnetic and earth searching) and related electronic units for attitude control which are originally to be installed in the payload module. This paper is intended to illustrate the thermal design considerations, concepts and guidelines on all units on the payload fixture for the successful space simulation ground test.

Thermal Analysis for Space Simulation Test Preparation

Jang-Joon Lee, Hui-Kyung Kim, Bum-Seok Hyun and Joon-Min Choi

Satellite Core Technology Department,
Korea Aerospace Research Institute

Thermal vacuum test is for verification of satellite thermal safety and each component's performance on the ground by simulation space thermal environment. The test usually requires preliminary thermal analysis for the following reasons. First, environmental heater sizing must be determined for simulating external incident heating conditions in space, protecting boxes under cold test condition and injecting heat into boxes in hot test condition. Second, predicting the time history of component's temperature is required to measure the test timeline before test is started. Most important one is to ensure that all the components must be operating within their temperature limits. The thermal analysis on this thermal vacuum test has one additional objective. That is to calculate the radiator area on payload fixture which is temporary substitute for payload module. For the thermal analysis, geometrical math model and thermal math model were developed. Using these models, the sizing of environmental heaters on body panels and radiator area for the payload fixture were determined. Through transient analysis, time line for the transition period was predicted. Also, operating time and duty for flight heaters of satellite components was found out.

Vertical Ozone Density Profiling by UV Radiometer onboard KSR-III

Seung-Hyun Hwang[1], Jhoon Kim[2], Soo-Jin Lee[1], Kwang-Soo Kim[1], Ki-Man Ji[1], Myung-Ho Shin[1], and Eui-Seung Chung[1]

[1]KSLV Program Office, Korea Aerospace Research Institute
[2]Global Environment Laboratory, Yonsei University

The UV radiometer payload was launched successfully from the west coastal area of Korea Peninsula aboard KSR-III on 28, Nov 2002. KSR-III was the Korean third generation sounding rocket and was developed as intermediate step to larger space launch vehicle with liquid propulsion engine system. UV radiometer onboard KSR-III consists of UV and visible band optical phototubes to measure the direct solar attenuation during rocket ascending phase. For UV detection, 4 channel of sensors were installed in electronics payload section and each channel has 255, 290, 310 nm center wavelengths, respectively. 450 nm channel was used as reference for correction of the rocket attitude during the flight. Transmission characteristics of all channels were calibrated precisely prior to the flight test at the Optical Lab. in KARI (Korea Aerospace Research Institute). During a total of 231s flight time, the onboard data telemetered to the ground station in real time. The ozone column density was calculated by this telemetry raw data. From the calculated column density, the vertical ozone profile over Korea Peninsula was obtained with sensor calibration data. Our results had reasonable agreements compared with various observations such as ground Umkhr measurement at Yonsei site, ozonesonde at Pohang site, and satellite measurements of HALOE and POAM. The sensitivity analysis of retrieval algorithm for parameters was performed and it was provided that significant error sources of the retrieval algorithm.

Design Consideration of Multipactor Phenomena Based on S-band Diplexer for Satellite Applications

Seung-Woon Choi, Day-Young Kim, Ki-Ho Kwon,
Tae-Byeong Chae, Jong-In Lee
[1]Satellite Electronics Dept., Satellite Technology Division,
Korea Aerospace Research Institute(KARI)

This review is concerned with the MP(multipactor) phenomena of the diplexer for RFDU DM of next generation satellite. The MP discharge is an avalanche-like increase of free electrons of RF components by due to the secondary electron emission, which comes from when electrons synchronized with the high input electric field in high vacuum condition. It can damage the physical structure of the equipment and can also be responsible for the performance degradation, and finally can make the mission failure of the satellite. In this work, we employed the 3D finite element method(FEM) to calculate the critical gap points and adopted ESTEC curve, MP susceptibility zone, to analyze the maximum handling RF power in the diplexer. The report shows that the maximum power of DB is about 3 watts and that of OB is about 7.5 wats. This work finally recommends that one should design the tx filter of the diplexer which is more wider design bandwidth(DB) upto the points to avoid the ears of the group delay especially the cavity type of RF components in space applications.

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CONTENTS

AA 01
AA 02
AA 03
AA 04
AA 05
AA 05
AA 07
AA 08
AA 09
AA 10
AA 11
AA 12
AA 13
AA 14
AA 15
AA 16
AA 17
AA 18
AA 19
AA 20
AA 21
AA 22
AA 23
AA 24
AA 25
AA 26
AA 27
AA 28
AA 29
AA 30
AA 31
AA 32
AA 33
AA 34
AA 35
AA 36
AA 37
AA 38
AA 39

AA 40
AA 41
AA 42
AA 43
AA 44

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