2021년 가을 제104차 한국천문학회 학술대회 안내

1. 학술대회 개요

(1) 일시 : 2021년 04월 15일 (목) ~ 04월 16일 (금)
(2) 장소 : 비대면 온라인 개최 / 한국천문연구원 운영본부 설치
- 구두발표 : 아일랜드 볼룸, 스톤홀, 윈드홀 + zoom
- 포스터발표 : 아일랜드 볼룸 로비 + 구글 웹하드
(3) 주최/주관 : 한국천문학회
(4) 후원 : 제주 컨벤션 뷰로, 한국과학기술단체총연합회

2. 등록

(1) 등록비
비대면참석 - 정회원(일반) : 200,000원 / 정회원(학생)이하 : 150,000원 / 비회원 : 250,000원/ 학부생 : 50,000원

(2) 연회비
연회비를 미납하신 회원은 아래 구좌로 송금하시거나 학회 당일 등록 장소에서 납부해 주십시오.
은행구좌로 송금할 때 반드시 성함을 기재하여 주시기 바랍니다.
정회원(일반) : 70,000원 / 정회원(학생) : 30,000원 / 준회원 : 30,000원
회장 : 500,000원 / 부회장 : 300,000원 / 이사 : 150,000원
※ 송금구좌: 468-25-0008-338 (국민은행) 예금주 : 사)한국천문학회
※ 당해년도 연회비를 납부하지 않은 회원에게는 총회에서 투표권이 제한됩니다.

3. 회원 가입

회원가입을 원하시는 분은 홈페이지 안내에 따라 입회원서를 작성하여 입회비와 함께 제출하시면 됩니다. [입회비: 정회원(10,000원)]

4. 입회원서

Membership Application Form of the Korean Astronomical Society

Membership No. (※For Office Use)			Approved Date (※For Office Use)		
Name			Nationality		
Institution					
Date of Birth	(yyyy-mm-dd)		Gender	M( ) F( )	
Phone (Office)		Fax (Office)		e-mail	
Highest Degree Earned	Bachelor ( )	Master ( )	PhD ( )		
	(Institution Degree Obtained From)			(Date Received)	
	(For Student)	Bachelor course( )	Master course( )	PhD Course( )	
Areas of Primary Interest	☐	광학천문분과 / Division of UV/Optical/IR Astronomy			
	☐	우주전파분과 / Space Warfare Division			
	☐	태양우주환경분과 / Solar and Space Physics Division			
	☐	행성계과학분과 / Planetary Science Division			
	☐	여성분과 / Women's Division			
	☐	한국젊은천문학자모임 / Young Astronomy Meeting			
	☐	천문관측기기분과 / Astronomical Instrumentation Division			
KAS Code of Ethics	☐	I have read and abide by the KAS code of Ethics			

I would like to become a member of the Korea Astronomy Society(KAS) and I agree to abide by the rules and regulations of the KAS.

Date : _____(yyyy-mm-dd)

Signature : _____

Recommender(signatures from TWO recommenders)[1)]

Affiliation _____ Name _____ Signature_____

Affiliation _____ Name _____ Signature_____

1) Qualifications of a Recommender :
- assistant professor, associate professor, full professor or
- senior researcher, principal researcher or
- full member of the KAS for 10 years

한국천문학회 모임 안내

◈ 광학천문분과 정기총회 개최
1) 일 시 : 2021년 10월 14일 15시50분
2) 장 소 : 제1발표장

◈ 젊은 천문학자 모임 정기총회 개최
1) 일 시 : 2021년 10월 14일 15시50분
2) 장 소 : 제2발표장

기타 안내

1. 교통안내

▶ 제주 휘닉스 섭지코지
https://phoenixhnr.co.kr/static/jeju/guide/traffic/map

◘ 급행버스 : 공항 2번 출구(앞) - 101번, 111번, 112번 (70분 소요, 고성리 하차)

◘ 호텔 무료 서틀 : 호텔 홈페이지를 통해 탑승 장소 확인 必

공항 > 휘닉스 제주			휘닉스 제주 > 공항		
구분	1회차	2회차	구분	1회차	2회차
출발시간	12:00	16:00	출발시간	10:30	14:30
도착시간	13:10	17:10	도착시간	11:40	15:40
탑승장소	제주공항 B-Zone (1, 2번) 주차장		탑승장소	오렌지동 CU 앞	

◘ 학회 무료 셔틀버스 휘닉스 제주 > 공항 : 10월 15일 15:00 예정
10월 1일까지 학회사무국으로 신청하여 주시기 바랍니다.

2. 식사안내 : 도시락으로 진행됨을 안내드립니다.
현장 구입은 불가하며, 가족식권의 경우 이메일로 신청
- 장소 : 호텔 내 별도 장소 (조식, 점심, 만찬)
- 가족 식권을 원하시는 회원께서는 회원명, 일자, 식권수량 작성하셔서 학회사무국으로 이메일 신청하시기 바랍니다. (비용 개별 안내)

2021 KAS Fall Meeting 10. 13 ~ 10. 15

2021 KAS Fall Meeting 10. 13

12:30~13:30	등록					
13:30~13:40	개회 에스이랩-샛별상 시상 : 문재연회원					
13:40~14:20	Invited Talk 1 - Jeong-Eun Lee (좌장: Woong-Tae Kim)					
14:20~14:40	휴식시간					
시간표	ISM & Star Formation 1 (좌장: Ji Yeon Seok)		Solar Activities (좌장: Yeon-Han Kim)		[특] LSB Universe with K-DRIFT (좌장: Jongwan Ko)	
14:40~14:55	구IS-01	Hyosun Kim	구SS-01	Heesu Yang	구KDC-01	Jongwan Ko
14:55~15:10	구IS-02	Sanghyuk Moon	구SS-02	Ji-Hye Baek	구KDC-02	Seunghyuk Chang
15:10~15:25	박IS-03	Hyeong-Sik Yun	구SS-03	Kyoung-Sun Lee	구KDC-03	Yunjong Kim
15:25~15:40			구SS-04	Jongchul Chae	구KDC-04	Gayoung Lee
15:40~15:55	구IS-04	Giseon Baek	구SS-05	Tetsuya Magara	구KDC-05	Woowon Byun
15:55~16:10	구IS-05	Hyeseung Lee	구SS-06	Kiwan Park	구KDC-06	Kwang-Il Seon
					구KDC-07	Jihye Shin
16:10~16:30	휴식시간					
시간표	ISM & Star Formation 2/ AGN/High Energy (좌장: Woong-Seob Jeong)		Stellar Astrophysics/ Stars/Star Clusters (좌장: Soung-Chul Yang)		[특] Rendezvous Mission to Apophis (좌장: Minsup Jeong)	
16:30~16:45	박IS-06	Nguyen Thi Phuong	구SA-01	Jangho Lim	구RMA-01	Young-Jun Choi
16:45~17:00			구SA-02	Sungmin Son	구RMA-02	Myung-Jin Kim
17:00~17:15	박IS-07	Joonho Kim	구SA-03	Jinhee Lee	구RMA-03	Jooyeon Geem
17:15~17:30			구SA-04	Beomdu Lim	구RMA-04	Sunho Jin
17:30~17:45	구GS-01	Jeongbhin Seo	구SA-05	Sang-Hyun Chun	구RMA-05	Youngmin Jeong Ahn
17:45~18:00	구GS-02	Hyunjin Cho	구SA-06	Gu Lim	구RMA-06	Hee-Jae Lee

2021 KAS Fall Meeting 10. 14						
09:30~10:10	Invited Talk 2 - Cheon Hwey Kim (좌장: Cheongho Han)					
10:10~10:50	Invited Talk 3 - Taysun Kimm (좌장: Ji-Hoon Kim)					
10:50~11:00	휴식시간					
시간표	Galaxy Evolution (좌장: Hyunmi Song)		High Energy Astrophysics (좌장: Hyeseung Lee)		[특] Gravitational Wave Detection Technology (좌장: Hyung Mok Lee)	
11:00~11:15	박GC-03	Seok-Jun Chang	구HA-01	Ji-Hoon Ha	구GWDT-01	June Gyu Park
11:15~11:30			구HA-02	Chanho Kim		
11:30~11:45	구GC-04	Changseok Kim	석HA-03	Minju Sim	구GWDT-02	Sungho Lee
11:45~12:00	구GC-05	Garreth Martin	구HA-04	Jiwoo Seo	구GWDT-03	June Gyu Park
12:00~12:15	구GC-06	Adarsh Ranjan	석HA-05	Jaewon Lee	구GWDT-04	Geunhee Gwak
12:15~12:30	구GC-07	Sandro Tacchella			구GWDT-05	Chan Roh
12:30~14:00	점심시간					
시간표	Nearby Galaxies/ Galaxy Clusters 2 (좌장: Hyunjin Shim)		Astronomical Instrumentation (좌장: Jongwan Ko)		[특] Life in Cosmos Exploration (좌장: Minsun Kim)	
14:00~14:15	구GC-08	Seong-A O	구AI-01	Myungshin Im	구LiCE-01	Min-Su Shin
14:15~14:30	구GC-09	Jinsu Rhee	구AI-02	Woong-Seob Jeong	구LiCE-02	Sungwook E. Hong
14:30~14:45	구GC-10	Hyungjin Joo	구AI-03	Taehyun Jung	구LiCE-03	Minsun Kim
14:45~15:00	구GC-11	Seong-Kook Lee	구AI-04	Seonghwan Choi	구LiCE-04	Thiem Hoang
15:00~15:15	구GC-12	Eunhee Ko	구AI-05	Gregory S.H. Paek	구LiCE-05	Ryun Young Kwon
15:15~15:30	구GC-13	Jeong Hwan Lee				(Discussion)
15:30~15:50	사진촬영					
15:50~17:00	포스터발표 및 분과회의					
	광학천문분과 총회		젊은 천문학자 모임 총회			
17:00~18:30	정기총회					
18:30~	만찬					

2021 KAS Fall Meeting 10. 15						
09:30~10:10	Invited Talk 4 - Andrew Rivkin (좌장: Hong-Kyu Moon)					
10:10~10:50	Invited Talk 5 - Seung-Urn Choe (좌장: Hong-Jin Yang)					
10:50~11:00	휴식시간					
시간표	Cosmology 1 (좌장: Donghui Jeong)		Education & Public Outreach (좌장: Yonggi Kim)		[특] Astronomy Cooperation between South and North Koreas (좌장: Young-Jun Choi)	
11:00~11:15	구GC-14	Bendict Bahr-Kalus	석EP-01	Sang-Geol Kim	초ACSN-01	Hong-woo Kim
11:15~11:30	구GC-15	Christoph Saulder	석EP-02	Min Heo		
11:30~11:45	구GC-16	Fei Qin	구EP-03	Sang hyun Ha	구ACSN-02	Insung Yim*
11:45~12:00	구GC-17	Wuhyun Sohn	구EP-04	Jongjin Lim	구ACSN-03	Sujin Kim*
12:00~12:15	구GC-18	Satadru Bag	구EP-05	Chang Hyun Baek	구ACSN-04	Hong-Jin Yang*
12:15~12:30	구GC-19	Suho Ryu	구EP-06	Taewoo Kim		*(20mins)
12:30~13:30	점심시간					
시간표	Cosmology 2 (좌장: Donghui Jeong)				Solar System/Astrobiology (좌장: Myung-Jin Kim)	
13:30~13:45	구GC-20	Yonghwi Kim			구SS-07	Dong-Heun Kim
13:45~14:00	구GC-21	Chunglee Kim			구SS-08	Sungsoo S. Kim
14:00~14:15	구GC-22	William Davison			구AB-01	Sungwook E. Hong
14:15~14:25	메타스페이스-우수포스터상 시상 및 폐회					

Schedule of Poster Session 10. 13 ~ 15

poster size : A0

분야	번호	이름	분야	번호	이름
고에너지/ 이론천문학	PHT-01	Ayan Bhattacharjee	교육홍보/ 기타	PAE-01	Suhyun Shin
	PHT-02	Paola Domínguez Fernández		PAE-02	Yonggi Kim
고천문학/ 천문역법	PHA-01	Yoon Kyung Se		PAE-03	Harim Kim
	PHA-02	Jaeyeon Hyun		PAE-04	Youngsil Choi
성간물질/ 별생성/우리은하	PIM-01	Rommy Aliste Castillo	천문화학/ 천문생물학	PAB-01	In-Ok Song
	PIM-02	Nguyen Chau Giang	천문우주 관측기술	PAT-01	Sang Hoon Oh
	PIM-03	Il-Joong Kim		PAT-02	Taeeun Kim
	PIM-04	Jaeyeong Kim		PAT-03	Dohoon Kim
	PIM-05	Gwibong Kang		PAT-04	Hojae Ahn
	PIM-06	Ayeon Lee		PAT-05	Su-Hwan Park
외부은하/은하단	PGC-01	Eunyu Lee		PAT-06	Ho-Soon Yang
	PGC-02	Jaewon Yoo		PAT-07	Bongkon Moon
	PGC-03	Minhee Hyun		PAT-08	Seonghwan Choi
	PGC-04	Bomi Park	태양/태양계	PSS-01	Soo Sang Kang
	PGC-05	Minsu Kim		PSS-02	Ilhoon Kim
	PGC-06	Jeein Kim		PSS-03	Hannah Kwak
	PGC-07	Soo-Chang Rey		PSS-04	Su-Chan Bong
	PGC-08	Soo-Chang Rey		PSS-05	Heesu Yang
	PGC-09	Shin-Jeong Kim		PSS-06	Jin-Yi Lee
	PGC-10	Hye-Jin Park		PSS-07	Yeon-Han Kim
	PGC-11	Shinna Kim		PSS-08	Kyuhyoun Cho
	PGC-12	Jiyeon Seong	항성,항성계/ 외계행성	PSA-01	Sophia Kim
	PGC-13	Jeeun Hwang		PSA-02	Jae-Joon Lee
	PGC-14	Duho Kim		PSA-03	Anupam Bhardwaj
우주론/암흑물질, 암흑에너지	PCD-01	Kyungjin Ahn		PSA-04	Seulgi Kim
	PCD-02	Se Yeon Hwang		PSA-05	Seok-Jun Chang

제1발표장 첫째날 : 10월 13일 (수)

12:30~13:30 등록

13:30~13:40 개 회 사 : 류동수 학회장
시 상 : 에스이랩-샛별상 수상 문재연 회원

초청강연 **좌장 : Woong-Tae Kim(김웅태)[SNU]**

13:40~14:20 초 IT-01
YSO Variability and Episodic Accretion
Jeong-Eun Lee(이정은)[KHU]

14:20~14:40 휴식시간

ISM & Star Formation 1 **좌장 : Ji Yeon Seok(석지연)[KASI]**

14:40~14:55 구IS-01
Multiepoch Optical Images of IRC+10216 Tell about the Central Star and the Adjacent Environment
Hyosun Kim(김효선)[KASI/ASIAA], Ho-Gyu Lee(이호규)[KASI], Youichi Ohyama[ASIAA], Ji Hoon Kim(김지훈)[NAOJ/METASPACE], Peter Scicluna[ASIAA/ESO], You-Hua Chu[ASIAA], Nicolas Mauron[Univ. de Montpellier], Toshiya Ueta[Univ. of Denver]

14:55~15:10 구IS-02
Role of Mass Inflow and Supernova Feedback on Nuclear Ring Star Formation
Sanghyuk Moon(문상혁), Woong-Tae Kim(김웅태)[SNU], Chang-Goo Kim(김창구), Eve C. Ostriker[Princeton University]

15:10~15:40 박IS-03
TRAO-TIMES: Investigating Turbulence and Chemistry in Two Star-forming Molecular clouds
Hyeong-Sik Yun(윤형식), Jeong-Eun Lee(이정은)[KHU], Yunhee Choi(최윤희)[KASI], Neal J. Evans II[KASI/University of Texas], Stella S. R. Offner[University of Texas], Giseon Baek(백기선), Yong-Hee Lee(이용희)[KHU], Minho Choi(최민호), Hyunwoo Kang(강현우)[KASI], Jungyeon Cho(조정연)[CNU], Seokho Lee(이석호), Ken'ichi Tatematsu[NAOJ], Mark H. Heyer[University of Massachusetts], Brandt A. L. Gaches[University of Texas], Yao-Lun Yang[University of Virginia]

15:40~15:55 구IS-04
Complex organic molecules detected in twelve high mass star forming regions with ALMA
Giseon Baek(백기선), Jeong-Eun Lee(이정은)[KHU], Tomoya Hirota[NAOJ], Kee-Tae Kim(김기태)[KASI], KaVA Star-Formation Science Working Group

15:55~16:10 구IS-05
Physical modeling of dust polarization spectrum by RAT alignment and disruption
Hyeseung Lee(이혜승)[UNIST/KASI], Thiem Hoang[KASI]

16:10~16:30 휴식시간

제1발표장 첫째날 : 10월 13일 (수)

ISM & Star Formation2/AGN/High Energy **좌장 : Woong-Seob Jeong(정웅섭)[KASI]**

16:30~17:00 박IS-06

GG Tauri A: gas properties and dynamics from the cavity to the outer disk

Nguyen Thi Phuong[KASI/Vietnam National Space Center/Université de Bordeaux], Anne Dutrey[Université de Bordeaux], Pham Ngoc Diep[KASI], Edwige Chapillon[Université de Bordeaux/IRAM], Stephane Guilloteau[Université de Bordeaux], Chang Won Lee(이창원)[KASI/UST], Emmanuel Di Folco[Université de Bordeaux], Liton Majumdar[HBNI], Jeff Bary[Colgate University], Tracy L. Beck[Space Telescope Science Institute], Audrey Coutens[Université de Toulouse], Otoniel Denis-Alpizar[Universidad Autónoma de Chile], Jean-Paul Melisse[Université de Bordeaux/IRAM], Vincent Pietu[IRAM], Thierry Stoecklin[Institut des Sciences Moléculaires], Yei-Wen Tang[ASIAA]

17:00~17:30 박IS-07

Study of Active Galactic Nuclei and Gravitational Wave Sources with Time-series Observation

Joonho Kim(김준호)[SNU/KASI], Myungshin Im(임명신)[SNU]

17:30~17:45 구GS-01

FR-II radio jets and the acceleration of UHECRs

Jeongbhin Seo(서정빈), Hyesung Kang(강혜성)[PNU], Dongsu Ryu(류동수)[UNIST]

17:45~18:00 구GS-02

Faraday Rotation Measure and Cosmic Magnetic Field

Hyunjin Cho(조현진), Dongsu Ryu(류동수), Ji-hoon Ha(하지훈)[UNIST], Hyesung Kang(강혜성)[PNU]

제2발표장 첫째날 : 10월 13일 (수)

12:30~13:30 등록

13:30~13:40 개회 (제1발표장)

초청강연 (제1발표장) **좌장 : Woong-Tae Kim(김웅태)[SNU]**

13:40~14:20 초 IT-01
YSO Variability and Episodic Accretion
Jeong-Eun Lee(이정은)[KHU]

14:20~14:40 휴식시간

Solar Activities **좌장 : Yeon-Han Kim(김연한)[KASI]**

14:40~14:55 구SS-01
F-Coronal Polarized Brightness Diagnostics using a Filter Ratio
Heesu Yang(양희수)[KASI], Kyuhyoun Cho(조규현)[SNU], Suchan Bong(봉수찬), Yeon-Han Kim(김연한), Seounghwan Choi(최성환)[KASI]

14:55~15:10 구SS-02
DeepSDO: Solar event detection using deep-learning-based object detection methods
Ji-Hye Baek(백지혜)[KASI/CNU], Sujin Kim(김수진), Seonghwan Choi(최성환), Jongyeob Park(박종엽), Jihun Kim(김지훈)[KASI], Wonkeum Jo(조원금), Dongil Kim(김동일)[CNU]

15:10~15:25 구SS-03
Fast Spectral Inversion of the Strong Absorption Lines in the Solar Chromosphere Based on a Deep Learning Model
Kyoung-Sun Lee(이경선), Jongchul Chae(채종철)[SNU], Eunsu Park(박은수), Yong-Jae Moon(문용재)[KHU], Hannah Kwak(곽한나), Kyuhyun Cho(조규현)[SNU]

15:25~15:40 구SS-04
Spectroscopic Detection of Alfvénic Waves in the Chromosphere of Sunspot Regions
Jongchul Chae(채종철), Kyuhyoun Cho(조규현)[SNU], Valery M. Nakariakov[University of Warwick/KHU], Kyung-Suk Cho(조경석)[KASI/UST], Ryun-Young Kwon(권륜영)[KASI]

15:40~15:55 구SS-05
A self-consistent model for the formation and eruption of a solar prominence
Tetsuya Magara[KHU]

15:55~16:10 구SS-06
Negative Turbulent Magnetic β Diffusivity effect in a Magnetically Forced System
Kiwan Park(박기완), Myung-Ki Cheoun(천명기)[Soongsil University]

16:10~16:30 휴식시간

제2발표장 첫째날 : 10월 13일 (수)

Stellar Astrophysics/Stars/Star Clusters **좌장 : Soung-Chul Yang(양성철)[KASI]**

16:30~16:45 구SA-01

Long-term simultaneous monitoring observations of SiO and H_2O masers toward Mira variable WX Serpentis

Jang Ho Lim(임장호)[CBNU], Jaeheon Kim(김재헌)[KASI], Seong Min Son(손성민), Kyung-Won Suh(서경원)[CBNU], Se-Hyung Cho(조세형), Haneul Yang(양하늘)[KASI/SNU], Dong-Hwan Yoon(윤동환)[KASI]

16:45~17:00 구SA-02

Twelve-year simultaneous monitoring of the SiO and H2O masers toward AGB stars: RT Vir, RR Aql, IRC-10151

Seong Min Son(손성민)[CBNU], Jaeheon Kim(김재헌)[KASI], Jang Ho Lim(임장호), Kyung-Won Suh(서경원)[CBNU], Se-Hyung Cho(조세형)[KASI/SNU], Dong-Hwan Yoon(윤동환)[KASI], Haneul Yang(양하늘)[KASI/SNU]

17:00~17:15 구SA-03

M to mid-L type members of nearby young moving groups from Gaia EDR3

Jinhee Lee(이진희)[PNU], Inseok Song(송인석)[University of Georgia], Simon J. Murphy[University of New South Wales Canberra]

17:15~17:30 구SA-04

A kinematic study of young stars in Monoceros OB1 and R1 associations

Beomdu Lim(임범두)[KHU], Yaël Nazé[Université de Liège], Jongsuk Hong(홍종석), Sungyong Yoon(윤성용)[KASI], Jinhee Lee(이진희)[PNU], Narae Hwang(황나래), Byeong-Gon Park(박병곤)[KASI], Jeong-Eun Lee(이정은)[KHU]

17:30~17:45 구SA-05

Metallicity-dependent mixing length in evolution models of red supergiant stars in IC 1613

Sang-Hyun Chun(천상현)[SNU/KASI], Sung-Chul Yoon(윤성철[SNU], Heeyoung Oh(오희영)[KASI]

17:45~18:00 구SA-06

Observational Feature of Ejecta-Companion Interaction of A Type Ia SN 2021hpr Via The Very Early Light Curve

Gu Lim(임구), Myungshin Im(임명신), Gregory S. H Paek(백승학), Sung-Chul Yoon(윤성철)[SNU], Changsu Choi(최창수)[SNU/KASI], Sophia Kim(김소피아), Jinguk Seo(서진국)[SNU], Wonseok Kang(강원석), Taewoo Kim(김태우)[NYSC], Hyun-Il Sung(성현일)[KASI], Yonggi Kim(김용기), Joh-Na Yoon(윤요라)[CBNU], IMSNG team

제3발표장 첫째날 : 10월 13일 (수)

12:30~13:30 등록

13:30~13:40 개회 (제1발표장)

초청강연 (제1발표장) **좌장 : Woong-Tae Kim(김웅태)[SNU]**

13:40~14:20 초 IT-01
YSO Variability and Episodic Accretion
Jeong-Eun Lee(이정은)[KHU]

14:20~14:40 휴식시간

[특] LSB Universe with K-DRIFT **좌장 : Jongwan Ko(고종완)[KASI]**

14:40~16:10
구KDC-01
A Brief Overview of the KASI-Deep Rolling Imaging Fast-optics Telescope(K-DRIFT): Exploring the Low-surface-brightness(LSB) Universe
Jongwan Ko(고종완)[KASI/UST]

구KDC-02
The Design of the Linear-Astigmatism-Free Three-Mirror System for K-DRIFT
Seunghyuk Chang(장승혁)[Center for integrated smart sensors]

구KDC-03
Fabrication, Assembly and Alignment of the Off-axis Freeform K-DRIFT Pathfinder
Yunjong Kim(김윤종)[KASI] ,Dohoon Kim(김도훈)[Green Optics]

구KDC-04
A Simulation Study for Mid-spatial Frequency Errors: Scattering Effects from Residual Optical Fabrication Errors
Gayoung Lee(이가영)[KNU], Yunjong Kim(김윤종)[KASI], Kwang-Il Seon(선광일)[KASI/UST]

구KDC-05
First Results from the K-DRIFT pathfinder: A Single Curved Stellar Stream in the Nearby Galaxy NGC 5907
Woowon Byun(변우원)[KASI/UST]

구KDC-06
Studies of LSB Features with K-DRIFT: Galactic Cirrus Clouds and Extragalactic Objects
Kwang-Il Seon(선광일)[KASI/UST]

구KDC-07
A novel simulation technique invented for studying low-surface brightness features in and around galaxies: Galaxy Replacement Technique (GRT)
Jihye Shin(신지혜), Kyungwon Chun(천경원)[KASI], Rory Smith, Jongwan Ko(고종완)[KASI/UST]

16:10~16:30 휴식시간

제3발표장 첫째날 : 10월 13일 (수)

[특] Rendezvous Mission to Apophis **좌장 : Minsup Jeong(정민섭)[KASI]**

16:30~16:45 구RMA-01

Rendezvous Mission to Apophis: I. Mission Overview

Young-Jun Choi(최영준)[KASI/UST] on behalf of the RMA Team

16:45~17:00 구RMA-02

Rendezvous Mission to Apophis: II. Science Goals

Myung-Jin Kim(김명진), Hong-Kyu Moon(문홍규)[KASI], Young-Jun Choi(최영준)[KASI/UST], Minsup Jeong(정민섭)[KASI], Masateru Ishiguro[SNU], Youngmin JeongAhn(정안영민), Hee-Jae Lee(이희재), Hongu Yang(양홍우), Seul-Min Baek(백설민), Jin Choi(최진), Chae Kyung Sim(심채경), Dukhang Lee(이덕행)[KASI], Dong-Heun Kim(김동흔)[KASI/CBNU], Eunjin Cho(조은진), Mingyeong Lee(이민경)[KASI/UST], Yoonsoo Bach(박윤수), Sunho Jin(진선호), Jooyeon Geem(김주연), Hangbin Jo(조항빈)[SNU], Sangho Choi(최상호)[Yonsei Univ.], Yaeji Kim(김예지)[Auburn Univ.], Yoonyoung Kim(김윤영), Yuna Kwon(권유나)[Univ of Braunschweig]

17:00~17:15 구RMA-03

Rendezvous Mission to Apophis: III. Polarimetry of S-type: For A Better Understanding of Surficial Evolution

Jooyeon Geem(김주연)[SNU], Minsup Jeong(정민섭)[KASI], Sunho Jin(진선호)[SNU], Chae Kyung Sim(심채경)[KASI], Yoonsoo P. Bach(박윤수), Masateru Ishiguro[SNU], Yuna G. Kwon(권유나)[Universität Braunschweig], Hong-Kyu Moon(문홍규), Young-Jun Choi(최영준), Myung-Jin Kim(김명진)[KASI]

17:15~17:30 구RMA-04

Rendezvous Mission to Apophis: IV. Investigation of the internal structure – A lesson from an analogical asteroid Itokawa

Sunho Jin(진선호)[SNU], Yaeji Kim(김예지)[Auburn Univ.], Hangbin Jo(조항빈)[SNU], Hongu Yang(양홍우)[KASI], Yuna Kwon(권유나)[Univ of Braunschweig], Masateru Ishiguro[SNU], Minsup Jeong(정민섭), Hong-Kyu Moon(문홍규)[KASI], Young-Jun Choi(최영준)[KASI/UST], Myung-Jin Kim(김명진)[KASI]

17:30~17:45 구RMA-05

Rendezvous Mission to Apophis: V. Wide-Angle Camera Science

Youngmin JeongAhn(정안영민), Hee-Jae Lee(이희재), Minsup Jeong(정민섭), Myung-Jin Kim(김명진), Jin Choi(최진), Hong-Kyu Moon(문홍규)[KASI], Young-Jun Choi (최영준)[KASI/UST]

17:45~18:00 구RMA-06

Rendezvous Mission to Apophis: VI. Observation Campaign during the 2021 Apparition

Hee-Jae Lee(이희재), Myung-Jin Kim(김명진)[KASI], Dong-Heun Kim(김동흔)[KASI/CBNU], Hong-Kyu Moon(문홍규)[KASI], Young-Jun Choi(최영준)[KASI/UST], on behalf of the Apophis Observation Team

제1발표장 둘째날 : 10월 14일 (목)

초청강연 **좌장 : Cheongho Han(한정호)[CBNU]**

09:30~10:10 초 IT-02
Looking back on the past 40 years as an astronomer
Chun-Hwey Kim(김천휘)[CBNU]

초청강연 **좌장 : Ji-Hoon Kim(김지훈)[SNU]**

10:10~10:50 초 IT-03
Supernova, radiation, and what now for realistic galaxy formation?
Taysun Kimm(김태선)[Yonsei University]

10:50~11:00 휴식시간

Galaxy Evolution **좌장 : Hyunmi Song(송현미)[CNU]**

11:00~11:30 박GC-03
Radiative Transfer in Highly Thick Media through Rayleigh and Raman Scattering with Atomic Hydrogen
Seok-Jun Chang(장석준)[Sejong University]

11:30~11:45 구GC-04
Testing delayed AGN feedback using star formation rate measurements by SED fitting with JCMT/SCUBA-2 data
Changseok Kim(김창석), Yashashree Jadhav, Jong-Hak Woo(우종학)[SNU], Aeree Chung(정애리), Junhyun Baek(백준현)[Yonsei University], Jeong Ae Lee(이정애), Jaejin Shin(신재진), Ho Seong Hwang(황호성), Rongxin Luo, Donghoon Son(손동훈), Hyungi Kim(김현기), Hyuk Woo(우혁)[SNU]

11:45~12:00 구GC-05
Preparing for low-surface-brightness science with the Rubin Observatory: characterisation of LSB tidal features from mock images
Garreth W. Martin[KASI/University of Arizona]

12:00~12:15 구GC-06
Probing neutral gas clouds and associated galaxies in the early universe
Adarsh Ranjan[KASI]

12:15~12:30 구GC-07
Tracing the first galaxies with the James Webb Space Telescope
Sandro Tacchella[UNIST)]

12:30~14:00 점심시간

제1발표장 둘째날 : 10월 14일 (목)

Nearby Galaxies/ Galaxy Clusters 2 **좌장 : Hyunjin Shim(심현진)[KNU]**

14:00~14:15 구GC-08
Large Scale Distribution of Globular Clusters in the Coma Cluster
Seong-A O(오성아), Myung Gyoon Lee(이명균)[SNU]

14:15~14:30 구GC-09
Galaxy identification with the 6D friends-of-friend algorithm for high resolution simulations of galaxy formation
Jinsu, Rhee(이진수)[Yonsei University], Pascal, Elahi[University of Western Australia], Sukyoung, K. Yi(이석영)[Yonsei University]

14:30~14:45 구 GC-10
Probing Intracluster Light of 10 Galaxy Clustersat z >1 with Deep HST WFC3/IR Imaging Data
Hyungjin Joo(주형진)[Yonsei University], M. James Jee(지명국)[Yonsei University/University of California], Jongwan Ko(고종완)[KASI/UST]

14:45~15:00 구 GC-11
A tale of two cities: Two galaxy clusters at cosmic noon
Seong-Kook Lee(이성국), Myungshin Im(임명신), Bomi Park(박보미)[SNU], Minhee Hyun(현민희)[KASI], Insu Paek(백인수)[SNU]

15:00~15:15 구 GC-12
Measuring the Environmental Quenching Timescales of Galaxy Clusters in the COSMOS field
Eunhee Ko(고은희), Myungshin Im(임명신), Seong-Kook Lee(이성국), Insu Paek(백인수), Bomi Park(박보미)[SNU]

15:15~15:30 구 GC-13
Mapping the Star Formation Activity of Five Jellyfish Galaxies in Massive Galaxy Clusters with GMOS/IFU
Jeong Hwan Lee(이정환), Myung Gyoon Lee(이명균)[SNU], Jae Yeon Mun(문재연)[Australian National University]

15:30~15:50 사진촬영

15:50~17:00 포스터 발표 및 분과회의

광학천문분과총회

17:00~18:30 정기총회

18:30~ 만찬

제2발표장 둘째날 : 10월 14일 (목)

초청강연 (제1발표장) **좌장 : Cheongho Han(한정호)[CBNU]**

09:30~10:10 초 IT-02
Looking back on the past 40 years as an astronomer
Chun-Hwey Kim(김천휘)[CBNU]

초청강연 **좌장 : Ji-Hoon Kim(김지훈)[SNU]**

10:10~10:50 초 IT-03
Supernova, radiation, and what now for realistic galaxy formation?
Taysun Kimm(김태선)[Yonsei University]

10:50~11:00 휴식시간

High Energy Astrophysics **좌장 : Hyeseung Lee(이혜승)[UNIST]**

11:00~11:15 구HA-01
Preexsiting Suprathermal Electrons and Preacceleration at Quasi-Perpendicular Shocks in Merging Galaxy Clusters
Ji-Hoon Ha(하지훈), Dongsu Ryu(류동수)[UNIST], Hyesung Kang(강혜성)[PNU], Sunjung Kim(김선정)[UNIST]

11:15~11:30 구HA-02
Features in broadband SEDs of young pulsar wind nebulae: existence of two different electron populations
Chanho Kim(김찬호), Hongjun An(안홍준)[CBNU]

11:30~11:45 석HA-03
Applying intrabinary shock model to various X-ray observation data
Minju Sim(심민주), Hongjun An(안홍준)[CBNU]

11:45~12:00 구HA-04
A correlation analysis about properties of quiescence magnetar
Jiwoo Seo(서지우), Jaewon Lee(이재원), Hongjun An(안홍준)[CBNU]

12:00~12:15 석HA-05
An Investigation of X-ray pulsation searches: Weighted vs unweighted H test
Jaewon Lee(이재원)[CBNU]

12:30~14:00 점심시간

Astronomical Instrumentation **좌장 : Jongwan Ko(고종완)[KASI]**

14:00~14:15 구AI-01
7-Dimensional Telescope (7DT) for multi-messenger astronomy
Myungshin Im(임명신), Hyung Mok Lee(이형목)[SNU], Jae-Hun Jung(정재훈)[Pohang University], Chunglee Kim(김정리)[Ewha Womans University], Arman Shafieloo, Z. Lucas Uhm[KASI], the GW Universe team

제2발표장 둘째날 : 10월 14일 (목)

Astronomical Instrumentation **좌장 : Jongwan Ko(고종완)[KASI]**

14:15~14:30 구AI-02
Status of KASI's Contribution to SPHEREx
Woong-Seob Jeong(정웅섭), Yujin Yang(양유진)[KASI/UST], Sung-Joon Park(박성준), Jeonghyun Pyo(표정현), Youngsoo Jo(조영수), Il-Joong Kim(김일중), Seungcheol Bang(방승철), Bomee Lee(이보미)[KAS], SPHEREx Korean Consorthium

14:30~14:45 구AI-03
Optical Clock Comparison using High-frequency VLBI Observations
Taehyun Jung(정태현)[KASI/UST], Myuoung-Sun Heo(허명선)[KRISS], Buseung Cho(조부승)[KIST], Sang-Oh Yi(이상오)[NGII], Jungwon Kim(김중원)[KAIST], Do-Heung Je(제도흥)[KASI], Do-Young Byun(변도영)[KASI/UST], Shuangjing Xu[KASI]

14:45~15:00 구AI-04
Python Package Prototype for Adaptive Optics Modeling and Simulation
Seonghwan Choi(최성환)[KASI], Byungchae Bang(방병채)[AntBridge], Jihun Kim(김지훈)[KASI], Gwanghee Jung(정광희)[AntBridge], Ji-Hye Baek(백지혜), Jongyeob Park(박종엽), Jungyul Han(한정열), Yunjong Kim(김윤종)[KASI]

15:00~15:15 구AI-05
IMSNG: Automatic Data Reduction Pipeline gppy for heterogeneous telescopes
Gregory S.H. Paek(백승학), Myungshin Im(임명신), Seo-won Chang(장서원), Changsu Choi(최창수), Gu Lim(임구), Sophia Kim(김소피아), Mankeun Jung(정만근), Sungyong Hwang(황선경), JoonhoKim(김준호)[SNU], Hyun-il Sung(성현일)[KASI], IMSNG team

15:30~15:50 사진촬영

15:50~17:00 포스터 발표 및 분과회의

17:00~18:30 정기총회 (제1발표장)

18:30~ 만찬

제3발표장 둘째날 : 10월 14일 (목)

초청강연 (제1발표장) **좌장 : Cheongho Han(한정호)[CBNU]**

09:30~10:10 초 IT-02
Looking back on the past 40 years as an astronomer
Chun-Hwey Kim(김천휘)[CBNU]

초청강연 **좌장 : Ji-Hoon Kim(김지훈)[SNU]**

10:10~10:50 초 IT-03
Supernova, radiation, and what now for realistic galaxy formation?
Taysun Kimm(김태선)[Yonsei University]

10:50~11:00 휴식시간

[특] Gravitational Wave Detection Technology **좌장 : Hyung Mok Lee(이형목)[SNU]**

11:00~11:30 구GWDT-01
Ground based interferometric gravitational wave detector and its technologies
June Gyu Park(박준규), Chang-Hee Kim(김창희), Sungho Lee(이성호), Yunjong Kim(김윤종), Hyeon Cheol Seong(성현철), Ueejeong Jeong(정의정), Soonkyu Je(제순규)[KASI]

11:30~11:45 구GWDT-02
Development and International Collaborations on Quantum Noise Reduction Technology for Gravitational Wave Detectors
Sungho Lee(이성호), Chang-Hee Kim(김창희), June Gyu Park(박준규), Yunjong Kim(김윤종), Hyeon Cheol Seong(성현철), Ueejeong Jeong(정의정), Soonkyu Je(제순규)[KASI], Young-Sik Ra(라영식), Geunhee Gwak(곽근희), Youngdo Yoon(윤영도), Byeong Yoon Go(고병윤), Hyunjin Kim(김현진), Chan Roh(노찬)[KAIST]

11:45~12:00 구GWDT-03
Development of 1064 nm squeezer for quantum non-demolition measurement in gravitational wave detector
June Gyu Park(박준규), Chang-Hee Kim(김창희), Sungho Lee(이성호), Yunjong Kim(김윤종), Hyeon Cheol Seong(성현철), Ueejeong Jeong(정의정), Soonkyu Je(제순규)[KASI]

12:00~12:15 구GWDT-04
Squeezed light generation at 1550nm
Geunhee Gwak(곽근희), Youngdo Yoon(윤영도), Byeong Yoon Go(고병윤), Chang-Hee Kim(김창희)[KAIST], Sungho Lee(이성호), June Gyu Park(박준규), Soonkyu Je(제순규), Ueejeong Jeong(정의정), Yunjong Kim(김윤종), Hyeon Cheol Seong(성현철)[KASI], Young-Sik Ra(라영식)[KAIST]

12:15~12:30 구GWDT-05
Mode-mismatch-robust squeezed light from a self-imaging optical parametric oscillator
Chan Roh(노찬), Geunhee Gwak(곽근희), Young-Sik Ra(라영식)[KAIST]

12:30~14:00 점심시간

제3발표장 둘째날 : 10월 14일 (목)

[특] Life in Cosmos Exploration **좌장 : Minsun Kim(김민선)[KASI]**

14:00~14:15 구LiCE-01
Research issues on biosignature and life in the Solar System and exoplanets
Min-Su Shin(신민수), Sun-Ju Chung(정선주)[KASI], LiCE team

14:15~14:30 구LiCE-02
Review on the Recent Studies about the Habitability
Sungwook E. Hong(홍성욱), Hyunwoo Kang(강현우), Ryun Young Kwon(권륜영)[KASI], LICE team

14:30~14:45 구LiCE-03
Current status and Prospect of the Radio SETI
Minsun Kim(김민선), Sungwook E. Hong(홍성욱), Taehyun Jung(정태현), Hyunwoo Kang(강현우), Min-Su Shin(신민수), Bong Won Sohn(손봉원)[KASI], and LiCE team

14:45~15:00 구LiCE-04
Discovery and in-depth research on Interstellar Objects
Thiem Hoang[KASI]

15:00~15:15 구LiCE-05
Maximizing the Probability of Detecting Interstellar Objects by using Space Weather Data
Ryun Young Kwon(권륜영), Minsun Kim(김민선), Thiem Hoang[KASI], LiCE Team

15:15~15:30 (Discussion)

15:30~15:50 사진촬영

15:50~17:00 포스터 발표 및 분과회의

17:00~18:30 정기총회 (제1발표장)

18:30~ 만찬

제1발표장 세째날 : 10월 15일 (금)

초청강연 **좌장 : Hong-Kyu Moon(문홍규)[KASI]**

09:30~10:10 초 IT-04
The Double Asteroid Redirection Test: NASA's First Planetary Defense Test Mission
Andrew S. Rivkin[Johns Hopkins University]

초청강연 **좌장 : Hong-Jin Yang(양홍진)[KASI]**

10:10~10:50 초 IT-05
Solar motion described in the Richan lili(日躔曆理), the Rìchán bùfǎ(日躔步法) and the Richan biao(日躔表) of the Yōngzhèng reign treatises on Calendrical Astronomy, Lixiang kaocheng houbian(曆象考成後編)
Seung-Urn choe(최승언)[SNU/Sohnam Institute for History of Astronomy], Min-Jeong Kang(강민정)[Institute for the Translation of Korean Classics], Seulki Kim(김슬기)[SNU], Sukjoo Kim(김석주)[Anyang University], Wonmo Suh(서원모)[Presbyterian University], Jinhyon Lee(이진현)[Sogang University], Yong Bok Lee(이용복)[Sohnam Institute for History of Astronomy]], Myon U Lee(이면우)[Chuncheon National University/Sohnam Institute for History of Astronomy], Yang, Hong-Jin(양홍진)[KASI]

10:50~11:00 휴식시간

Cosmology 1 **좌장 : Donghui Jeong(정동희)[KIAS]**

11:00~11:15 구GC-14
The Kaiser Rocket Effect in Cosmology
Benedict Bahr-Kalus[KASI]

11:15~11:30 구GC-15
The DESI peculiar velocity survey
Christoph Saulder[KASI]

11:30~11:45 구GC-16
Cosmology with peculiar velocity surveys
Fei Qin[KASI]

11:45~12:00 구GC-17
High-resolution CMB bispectrum estimator for future surveys
Wuhyun Sohn(손우현)[KASI]

12:00~12:15 구GC-18
Identifying Lensed Quasars and measuring their Time-Delays in Unresolved Systems
Satadru Bag[KASI]

12:15~12:30 구GC-19
Excursion-Set Modeling of the Splashback Mass Function and its Cosmological Usefulness
Suho Ryu(유수호), Jounghun Lee(이정훈)[SNU]

12:30~13:30 점심시간

제1발표장 세째날 : 10월 15일 (금)

Cosmology 2 **좌장 : Donghui Jeong(정동희)[KIAS]**

13:30~13:45 구GC-20
Horizon Run Spin-off Simulations for Studying the Formation and Expansion history of Early Universe
Yonghwi Kim(김용휘), Jaehong Park(박재홍), Changbom Park(박창범), Juhan Kim(김주한), Ankit Singh, Jaehyun Lee(이재현)[KIAS], Jihye Shin(신지혜)[KASI]

13:45~14:00 구GC-21
Horizon Run 5 Black Hole Populations and Pulsar Timing Array
Chunglee Kim(김정리)[Ewha Womans University], Hyo Sun Park(박효선)[Bryn Mawr College], Juhan Kim(김주한)[KIAS], Andrea Lommen[Haverford College]

14:00~14:15 구GC-22
STag: Supernova Tagging and Classification
William Davison, David Parkinson[KASI], Brad E. Tucker[Australian National University]

14:15~14:25 메타스페이스 - 우수포스터상 시상 및 폐회

제2발표장 세째날 : 10월 15일 (금)

초청강연 (제1발표장) **좌장 : Hong-Kyu Moon(문홍규)[KASI]**

09:30~10:10 초 IT-04
The Double Asteroid Redirection Test: NASA's First Planetary Defense Test Mission
Andrew S. Rivkin[Johns Hopkins University]

초청강연 (제1발표장) **좌장 : Hong-Jin Yang(양홍진)[KASI]**

10:10~10:50 초 IT-05
Solar motion described in the Richan lili(日躔曆理), the Rìchán bùfǎ(日躔步法) and the Richan biao(日躔表) of the Yōngzhèng reign treatises on Calendrical Astronomy, Lixiang kaocheng houbian(曆象考成後編)
Seung-Urn choe(최승언)[SNU/Sohnam Institute for History of Astronomy], Min-Jeong Kang(강민정)[Institute for the Translation of Korean Classics], Seulki Kim(김슬기)[SNU], Sukjoo Kim(김석주)[Anyang University], Wonmo Suh(서원모)[Presbyterian University], Jinhyon Lee(이진현)[Sogang University], Yong Bok Lee(이용복)[Sohnam Institute for History of Astronomy]], Myon U Lee(이면우)[Chuncheon National University/Sohnam Institute for History of Astronomy], Yang, Hong-Jin(양홍진)[KASI]

10:50~11:00 휴식시간

Education & Public Outreach **좌장 : Yonggi Kim(김용기)[CBNU]**

11:00~11:15 석EP-01
A study on the effectiveness of STEAM education program applying 3D-modeling at astronomy Units
Sang-Geol Kim(김상걸), Hyoungbum Kim(김형범), Yonggi Kim(김용기), Hongsoon Choi(최홍순)[CBNU]

11:15~11:30 석EP-02
STEAM Training Program for Constellation Space Composition Using Laser Cutter and LED Light Source
Min Heo(허민), Geoyung Han Yoo(유경한), Yonggi Kim(김용기), HyoungBum KIM(김형범)[CBNU]

11:30~11:45 구EP-03
Development and Introduction of Virtual Reality Astronomy Education Program Development
Sanghyun Ha(하상현), Jungjoo Sohn(손정주)[KNUE], Soonchang Park(박순창)[METASPACE]

11:45~12:00 구EP-04
Development of the astronomical education kits using 3D printer and its application
Jongjin Lim(임종진), Yonggi Kim(김용기), Hyoungbum Kim(김형범), Taeyong Ha(하태용)[CBNU]

12:00~12:15 구EP-05
Development and Fabrication of Astronomical Exhibitions
Chang Hyun Baek(백창현), Cheolhee Kim(김철희)[NSM]

12:15~12:30 구EP-06
Hybrid Astronomy and Space Science Room
Taewoo Kim(김태우), Sun-gill Kwon(권순길), Sungjin Ahn(안성진), Wonseok Kang(강원석), Miso Park(박미소), Sohee Kim(김소희)[NYSC]

12:30~13:30 점심시간

14:15~14:25 메타스페이스 - 우수포스터상 시상 및 폐회(제1발표장)

제3발표장 세째날 : 10월 15일 (금)

초청강연 (제1발표장) **좌장 : Hong-Kyu Moon(문홍규)[KASI]**

09:30~10:10 초 IT-04
The Double Asteroid Redirection Test: NASA's First Planetary Defense Test Mission
Andrew S. Rivkin[Johns Hopkins University]

초청강연 (제1발표장) **좌장 : Hong-Jin Yang(양홍진)[KASI]**

10:10~10:50 초 IT-05
Solar motion described in the Richan lili(日躔曆理), the Rìchán bùfǎ(日躔步法) and the Richan biao(日躔表) of the Yōngzhèng reign treatises on Calendrical Astronomy, Lixiang kaocheng houbian(曆象考成後編)
Seung-Urn choe(최승언)[SNU/Sohnam Institute for History of Astronomy], Min-Jeong Kang(강민정)[Institute for the Translation of Korean Classics], Seulki Kim(김슬기)[SNU], Sukjoo Kim(김석주)[Anyang University], Wonmo Suh(서원모)[Presbyterian University], Jinhyon Lee(이진현)[Sogang University], Yong Bok Lee(이용복)[Sohnam Institute for History of Astronomy]], Myon U Lee(이면우)[Chuncheon National University/Sohnam Institute for History of Astronomy], Yang, Hong-Jin(양홍진)[KASI]

10:50~11:00 휴식시간

[특] Astronomy Cooperation between South and North Koreas 좌장 : Young-Jun Choi(최영준)[KASI]

11:00~11:30 초ACSN-01
Cooperation between South Korea and North Korea through wind resource investigation and academic events
hong-woo Kim(김홍우)[KIER]

11:30~11:50 구ACSN-02
A Study on the Cooperation Plan with Astronomical R&D Issues between South and North Korea
Insung Yim(임인성), Hong-Jin Yang(양홍진)[KASI]

11:50~12:10 구ACSN-03
Study on Status of Solar Astronomy in North Korea
Sujin Kim(김수진), Hong-Jin Yang(양홍진), Jong-Kyun Chung(정종균), Insung Yim(임인성)[KASI]

12:10~12:30 구ACSN-04
A Study on the North Korea's Astronomical Research based on the Academic Journal
Hong-Jin Yang(양홍진), Insung Yim(임인성)[KASI]

12:30~13:30 점심시간

제3발표장 세째날 : 10월 15일 (금)

Solar System/Astrobiology **좌장 : Myung-Jin Kim(김명진)[KASI]**

13:30~13:45 구SS-07

Photometric study of Main-belt asteroid (298) Baptistina

Dong-Heun Kim(김동흔)[KASI/CBNU], Myung-Jin Kim(김명진), Hee-Jae Lee(이희재)[KASI], Murat Kaplan[Akdeniz Universitesi], Orhan Erece[Akdeniz Universitesi/TÜBITAK National Observatory], Taewoo Kim(김태우)[NYSC], Joh-Na Yoon(윤요나)[CBNU], Anna Marciniak[Adam Mickiewicz University], Hong-Kyu Moon(문홍규)[KASI], Young-Jun Choi(최영준)[KASI/UST], Yonggi Kim(김용기)[CBNU]

13:45~14:00 구SS-08

Reflectance-Color Trends on the Lunar Mare Surface

Sungsoo S. Kim(김성수)[KHU], Chae Kyung Sim(심채경)[KASI]

14:00~14:15 구AB-01

Panspermia in a Milky Way-like Galaxy

Sungwook E. Hong(홍성욱)[KASI], Raphael Gobat[Pontificia Universidad Catolica de Valparaiso], Owain Snaith[Observatoire de Paris], Sungryong Hong(홍성용)[KASI]

14:15~14:25 메타스페이스 - 우수포스터상 시상 및 폐회(제1발표장)

포 스 터 발 표

고에너지/이론천문학(High energy astronomy/Theoretical astronomy)

PHT-01

Could There Be a Unified Spectral Model for Black Holes and Neutron Stars?

Ayan Bhattacharjee[UNIST], Sandip K. Chakrabarti[ICSP]

PHT-02

Properties of polarised emission in radio relics

Paola Domínguez Fernández[UNIST]

고천문학/천문역법(Historical astronomy/Ephemerides)

PHA-01

Current status of automatic translation service by artificial intelligence specialized in Korean astronomical classics

Yoon Kyung Seo(서윤경), Sang Hyuk Kim(김상혁), Young Sook Ahn(안영숙), Go-Eun Choi(최고은), Young Sil Choi(최영실)[KASI], Hangi Baik(백한기), Bo Min Sun(선보민)[Institute for the Translation of Korean Classics], Hyun Jin Kim(김현진), Byung Sook Choi(최병숙)[NuriIDT Co.], Sahng Woon Lee(이상원), Raejin Park(박예진)[LLsoLLu Co.]

PHA-02

Analysis of the Sohyeon-Donggungilgi Records of Solar Halo Observations

Jaeyeon Hyun(현재연), Byeong-Hee Mihn(민병희)[UST/KASI], Ki-Won Lee(이기원)[Daegu Catholic University], Sang Hyuk Kim(김상혁)[KASI], Uhn Mee Bahk(박은미)[KASI/CBNU]

성간물질/별생성/우리은하(ISM/Star Formation/Milky Way Galaxy)

PIM-01

Optical spectroscopy of LMC SNRs to reveal the origin of [P II] knots

Rommy L. S. E. Aliste C., Bon-Chul Koo(구본철)[SNU], Ji Yeon Seok(석지연)[KASI], Yong-Hyun Lee(이용현)[Samsung SDS], Dongkok Kim(김동국)[SNU]

PIM-02

Modeling Grain Rotational Disruption by Radiative Torques and Extinction of Active Galactic Nuclei

Nguyen Chau Giang, Thiem Hoang[KASI/UST]

PIM-03

Catalog of the Paα-emitting Sources observed in the Carina Region

Il-Joong Kim(김일중), Jeonghyun Pyo(표정현), Woong-Seob Jeong(정웅섭)[KASI]

PIM-04

Tracing history of the episodic accretion process in protostars

Jaeyeong Kim(김재영)[KASI], Jeong-Eun Lee(이정은), Chul-Hwan Kim(김철환)[KHU], Tien-Hao Hsieh[3Max-Planck-Institute], Yao-Lun Yang[University of Virginia], Nadia Murillo[RIKEN Wako Institute], Yuri Aikawa[University of Tokyo], Woong-Seob Jeong(정웅섭)[KASI]

PIM-05

Chemical and Kinematic Properties of Sagittarius Stellar Streams

Gwibong Kang(강귀봉), Young Sun Lee(이영선), Young Kwang Kim(김영광)[CNU]

PIM-06

Investigation of heating and accretion event of Milky Way disk

Ayeon Lee(이아연), Young Sun Lee(이영선), Young Kwang Kim(김영광)[CNU]

포 스 터 발 표

외부은하/은하단(Galaxy Evolution/Cosmology)

PGC-01

Properties of Shocks in Simulated Merging Clusters

Eunyu Lee(이은유), Dongsu Ryu(류동수)[UNIST], Hyesung Kang(강혜성)[PNU]

PGC-02

How to quantify the similarity of 2D distributions: Comparison of spatial distribution of Dark Matter and Intracluster light

Jaewon Yoo(유재원), Jongwan Ko(고종완)[KASI/UST], Cristiano G. Sabiu[University of Seoul], Kyungwon Chun(천경원), Jihye Shin(신지혜)[KASI], Ho Seong Hwang(황호성)[SNU], Rory Smith, Hyowon Kim(김효원)[KASI/UST]

PGC-03

Large Scale Structures at z~1 in SA22 Field and Environmental Dependence of Galaxy Properties

Minhee Hyun(현민희)[KASI/SNU], Myungshin Im(임명신), Jae-Woo Kim(김재우), Seong-Kook Lee(이성국), Insu Paek(백인수)[SNU]

PGC-04

Discovery of Massive Galaxy Cluster Candidates in the Southern Sky

Bomi Park(박보미), Myungshin Im(임명신), Joonho Kim(김준호), Minhee Hyun(현민희), Seong-Kook Lee(이성국)[SNU], Jae-Woo Kim(김재우)[KASI

PGC-05

HI superprofiles of galaxies from THINGS and LITTLE THINGS

Minsu Kim(김민수), Se-Heon Oh(오세헌)[Sejong University]

PGC-06

HI gas properties of BAT-BASS AGN host galaxies

Jeein Kim(김지인), Aeree Chung(정애리), Junhyun Baek(백준현)[Yonsei University], Kyuseok Oh(오규석)[KASI], O. Ivy Wong[CSIRO], Michael J. Koss[Eureka Scientific, Space Science Institute], BASS team

PGC-07

Compact Elliptical Galaxies Hosting Active Galactic Nuclei in Isolated Environments

Soo-Chang Rey(이수창)[CNU], Kyuseok Oh(오규석)[KASI], Suk Kim(김석)[CNU]

PGC-08

Star-forming Dwarf Galaxies in Filamentary Structures around the Virgo Cluster

Soo-Chang Rey(이수창)[CNU], Jiwon Chung(정지원)[KASI], Suk Kim(김석), Youngdae Lee(이영대)[CNU]

PGC-09

HI gas kinematics of paired galaxies in the cluster environment from ASKAP pilot observations

Shin-Jeong Kim(김신정), Se-Heon Oh(오세헌), Minsu Kim(김민수), Hye-Jin Park(박혜진), Shinna Kim(김신나)[Sejong University], ASKAP WALLABY Science Working Group 2[SWG2]

PGC-10

Gas dynamics and star formation in NGC 6822

Hye-Jin Park(박혜진), Se-Heon Oh(오세헌)[Sejong University], Jing Wang, Yun Zheng[KIAA], Hong-Xin Zhang[University of Science and Technology of China], W.J.G. de Blok[ASTRON/University of Cape Town/University of Groningen]

PGC-11

High-resolution mass models of the Large Magellanic Cloud

Shinna Kim(김신나), Se-Heon Oh(오세헌)[Sejong University], Bi-Qing For[ICRAR], Yun-Kyeong Sheen(신윤경)[KASI]

포 스 터 발 표

외부은하/은하단(Galaxy Evolution/Cosmology)

PGC-12

Searching for Spectrally Variable AGNs using Multi-epoch Spectra from SDSS

Jiyeon Seong(성지연), Minjin Kim(김민진)[KNU], Dong-Chan Kim(김찬경), Il-Sang Yoon(윤일상)[NRAO], Jaejin Shin(신재진)[KNU]

PGC-13

The strategy to catch more early light curves of supernovae

Jeeun Hwang(황지은), Myungshin Im(임명신), Gregory S.H. Paek(백승학)[SNU], IMSNG team

PGC-14

Merging histories of Galaxies in Deep and Wide Images of 7 Abell Clusters with Various Dynamical States

Duho Kim(김두호), Yun-Kyeong Sheen(신윤경)[KASI], Yara L. Jaffe[Universidad de Valparaiso], Adarsh Ranjan[KASI], Sukyoung K. Yi(이석영)[Yonsei University], Rory Smith[KASI]

우주론(Cosmology)

PCD-01

Probing the Early Phase of Reionization through LiteBIRD

Kyungjin Ahn(안경진)[Chosun University], Hina Sakamoto, Kiyotomo Ichiki[University of Nagoya], Hyunjin Moon(문현진)[Chosun University], Kenji Hasegawa[University of Nagoya]

PCD-02

Detecting the Baryon Acoustic Oscillations in the N-point Spatial Statistics of SDSS Galaxies

Se Yeon Hwang(황세연), Sumi Kim(김수미), Cristiano G. Sabiu, In Kyu Park(박인규)[University of Seoul]

교육홍보 / 기타(Astronomy Outreach and Education)

PHA-01

Academic exchange and social activity of Korea young astronomers meeting (KYAM) in the COVID-19 era

Suhyun Shin(신수현)[SNU], Migi Jeong(정미지)[CNU], Byeongha Moon(문병하)[UST], Jeongin Moon(문정인)[Sejong University], Suyeon Son(손수연)[KNU], Seong-A O(오성아)[KHU], Sieun Lee(이시은)[KASI]

PHA-02

Recent progress in astronomy education in Makerspace situation

Yonggi Kim(김용기), Hyoungbum Kim(김형범)[CBNU]

PHA-03

Application and Development of astronomical STEAM program for Science Culture and Creative Education

Harim Kim(김하림), Hyoungbum Kim(김형범)[CBNU], Ah-Chim Sul(설아침)[KASI]

PHA-04

An Oral History Study of Overseas Korean Astronomer: John D. R. Bahng's Case

Youngsil Choi(최영실), Yoon Kyung Seo(서윤경)[KASI], Hyung Mok Lee(이형목)[KASI/SNU]

천문화학/천문생물학(Astrochemistry/Astrobiology)

PAB-01

Discovery of C_2 Swan Band and CN emission in Spark Discharge Experiment

In-Ok Song(송인옥)[Korea Science of Academy of KAIST], Younghoon Mo(모영훈)[Korea Science of Academy of KAIST/SNU], Jein Ryu(류제인)[Korea Science of Academy of KAIST/KAIST], Hoyon Chang[Korea Science of Academy of KAIST/SNU], Ki-Wook Hwang(황기욱)[Korea Science of Academy of KAIST/KAIST], Man-Seog Chun(천만석), Jinho Oh(오진호), Sangjoon Hahn(한상준)[Korea Science of Academy of KAIST]

포 스 터 발 표

천문우주관측기술(Astrophysical Techniques)

PAT-01

Deep learning classification of transient noises using LIGOs auxiliary channel data

SangHoon Oh(오상훈), Whansun Kim(김환선), Edwin J. Son(손재주)[NIMS], Young-Min Kim(김영민)[UNIST]

PAT-02

Development progress in the Maunakea Spectroscopic Explorer's Exposure Time Calculator (MSE-ETC)

Taeeun Kim(김태은), Changgon Kim(김창곤), Tae-Geun Ji(지태근), Hojae Ahn(안호재), Mingyeong Yang(양민경), Soojong Pak(박수종)[KHU], Sungwook E. Hong(홍성욱)[KASI], Jennifer Sobeck, Kei Szeto[Maunakea Spectroscopic Explorer/Canada France Hawaii Telescope], Jennifer Marshall[Maunakea Spectroscopic Explorer/Texas A&M University], Christian Surace[Maunakea Spectroscopic Explorer/Laboratoire d'Astrophysique de Marseille]

PAT-03

Confocal off-axis optical system with freeform mirror, application to Photon Simulator (PhoSim)

Dohoon Kim(김도훈)[KHU], Sunwoo Lee(이선우)[KBSI], Jimin Han(한지민)[KHU], Woojin Park(박우진)[KASI], Soojong Pak(박수종)[KHU], Jaewon Yoo(유재원), Jongwan Ko(고종완)[KASI/UST], Dae-Hee Lee(이대희)[KASI], Seunghyuk Chang(장승혁)[Center for Integrated Smart Sensors], Geon-Hee Kim(김건희)[Hanbat National University], David Valls-Gabaud[LERMA], Daewook Kim(김대욱)[University of Arizona]

PAT-04

Standard Calibration for Broadband and Narrowband Filters of KHAO 0.4 m Telescope

Hojae Ahn(안호재), Inhwan Jeong(정인환)[KHU], Gregory S.H. Paek(백승학)[SNU], Sumin Lee(이수민), Changgon Kim(김창곤), Soojong Pak(박수종)[KHU], Hyunjin Shim(심현진)[KNU], Myungshin Im(임명신)[SNU]

PAT-05

Characterization of the performance of the next-generation controller for the BOES CCD

Su-Hwan Park(박수환)[KNU/KASI], Young Sam Yu(유영삼), Hyun-Il Sung(성현일), Yoon-Ho Park(박윤호), Sang-Min Lee(이상민), Seung-Cheol Bang(방승철), Moo-Young Chun(천무영), Hyeon-Cheol Seong(성현철)[KASI], Minjin Kim(김민진)[KNU]

PAT-06

Development Plan for the First GMT ASM Reference Body

Ho-Soon Yang(양호순)[KRISS],Chang-Jin Oh(오창진)[University of Arizona], Roberto Biasi, Daniele Gallieni[AdOptica]

PAT-07

Space Telescope Pre-study of KASI for the Next Decades

Bongkon Moon(문봉곤), Dae-Hee Lee(이대희), Young-Jun Choi(최영준), Wonyong Han(한원용), Ukwon Nam(남욱원), Youngsik Park(박영식), Won-Kee Park(박원기), Duk-hang Lee(이덕행), Woojin Kim(김우진), Jeong-Yeol Han(한정열), Seonghwan Choi(최성환), Jihun Kim(김지헌), Jongwan Ko(고종완), Il-joong Kim(김일중), Hong-Kyu Moon(문홍규)[KASI]

PAT-08

Development Plan of Package-type Instruments for Next-Generation Space Weather Observation Network

Seonghwan Choi(최성환), Young-Sil Kwak(곽영실), Wookyoung Lee(이우경)[KASI], KASI Space Weather Team

포 스 터 발 표

태양/태양계(Solar/Solar System)

PSS-01

Measurement of Radiative Loss from the Multi-layer Spectral Inversion of the Ha line and Ca II 8542 line taken by the FISS

Soo Sang Kang(강수상), Jongchul Chae(채종철)[SNU]

PSS-02

Optical telescope with spectro-polarimetric camera on the moon

Ilhoon Kim(김일훈)[SLLAB], Sukbum Hong(홍석범)[Korean Minjok Leadership Academy], Joohyun Kim(김주현)[KARI], Haingja Seo(서행자)[HANCOM inSPACE], Jeong hyun Kim(김정현)[SLLAB], Hwajin Choi(최화진)[SLLAB/CNU]

PSS-03

Spectroscopic Detection of Alfvénic Waves in Chromospheric Mottles of a Solar Quiet Region

Hannah Kwak(곽한나), Jongchul Chae(채종철)[SNU]

PSS-04

CODEX Filter Configuration

Su-Chan Bong(봉수찬), Heesu Yang(양희수), Jihun Kim(김지훈), Jae-Ok Lee(이재옥), Yeon-Han Kim(김연한)[KASI], Kyuhyoun Cho(조규현)[SNU], Nelson L. Reginald[NASA/Catholic University of America], Qian Gong[NASA], Jason G. Budinoff[NASA/ADNET Systems], Jeffrey S. Newmark[NASA]

PSS-05

Next Generation Solar Telescope Global Network: Three Eyes for the Studies on the Space Weather Prediction and the Solar Chromospheric Activities

Heesu Yang(양희수), Seounghwan Choi(최성환), Jihun Kim(김지훈), Sujin Kim(김수진), Eun-Kyung Lim(임은경), Juhyung Kang(강주형), Dong-Uk Song(송동욱), Ji-Hye Baek(백지혜), Jongyeob Park(박종엽)[KASI]

PSS-06

Simple modeling to explore temperatures, heated temperature, and Kappa values of a current sheet observation

Jin-Yi Lee(이진이)[KHU], John C. Raymond, Katharine K. Reeves, Chengcai Shen[Harvard & Smithsonian], Stephen Kahler[Air Force Research Laboratory], Yong-Jae Moon(문용재)[KHU], Yeon-Han Kim(김연한)[KASI/UST]

PSS-07

Development of a diagnostic coronagraph on the ISS: CODEX progress report

Yeon-Han Kim(김연한), Seonghwan Choi(최성환), Su-Chan Bong(봉수찬)[KASI], Kyungsuk Cho(조경석)[KASI/UST], Jeffrey Newmark, Nat. Gopalswamy[NASA], KASI-NASA Coronagraph Team

PSS-08

Subsurface structure of a sunspot inferred from umbral flashes

Kyuhyoun Cho(조규현)[SNU]

항성, 항성계/ 외계행성(Stars, star clusters/Exoplanets)

PSA-01

Current Status of Intensive Monitoring Survey of Nearby Galaxies and Core-Collapse Supernovae Observational Research

Sophia Kim(김소피아), Myungshin Im(임명신)[SNU], Changsu Choi(최창수)[KASI], Gu Im(임구), Gregory S. Paek, IMSNG Team

PSA-02

Identifying clusters of red supergiants in Galactic plane using 2MASS and GAIA G band colors

Jae-Joon Lee (이재준), Sang Hyun Chun (천상현)[KASI]

포 스 터 발 표

항성, 항성계/ 외계행성(Stars, star clusters/Exoplanets)

PSA-03

Pushing precision and accuracy of RR Lyrae variables as distance indicators

Anupam Bhardwaj, Soung-Chul Yang(양성철)[KASI]

PSA-04

The Kinematic Properties of Young Stars in NGC 281: its implication on star formation process

Seulgi Kim(김슬기)[Sejong University], Beomdu Lim(임범두)[KHU]

PSA-05

STaRS Gen 2: Sejong Radiative Transfer through Raman and Rayleigh Scattering in Dusty Medium

Seok-Jun Chang(장석준), Hee-Won Lee(이희원)[Sejong University],
Kwang-Il Seon(선광일)[KASI/UST]

2021년도 가을 한국천문학회 학술대회
발표논문 초록

구두 발표 논문 초록

포스터 발표 논문 초록

구 두 발 표 초 록

초 청 강 연

[초 IT-01] YSO Variability and Episodic Accretion

Jeong-Eun Lee
School of Space Research, Kyung Hee University, Republic of Korea

Variability in young stellar objects (YSOs) can be caused by various time-dependent phenomena associated with star formation, including accretion rates, geometric changes in the circumstellar disks, stochastic hydromagnetic interactions between stellar surfaces and inner disk edges, reconnections within the stellar magnetosphere, and hot/cold spots on stellar surfaces. Among these YSO variability phenomena, bursts of accretion, which are the most remarkable variability, usually occur sporadically, making it challenging to catch the bursting moments observationally. However, the burst accretion process significantly affects the chemical conditions of the disk and envelope of a YSO, which can be used as a prominent tracer of episodic accretion. I will introduce our ensemble studies of YSO variability at mid-IR and submillimeter and also cover the ALMA observations of several YSOs in the burst accretion phase, especially in the view of chemistry.

[초 IT-02] Looking back on the past 40 years as an astronomer

Kim, Chun-Hwey
Chungbuk National University

1980년 3월 대학원에 진학한 후, 나는 본격적으로 천문학도의 길로 들어섰다. 대학원에서 근성점 운동을 보이는 세 개의 식쌍성을 광전관측한 결과를 석사학위논문으로 제출하여 졸업한 후, 1982년 3월 국립천문대(1974.9.-1986.3) 에 입사하였다. 국립천문대가 정부출연연구기관인 한국전자통신연구소 부설 천문우주과학연구소(1986.3-1991.10)로 바뀌고, 한국표준과학연구원 천문대(1991.10-1999.5)로 변경되는 11년의 기간을 보낸 후, 나는 1993년 3월 충북대학교 천문우주학과로 이직하였다. 2019년 2월 정년퇴직하여 현재 명예교수와 석좌연구원으로 28년간 충북대학교에 재직하고 있다. 그러니까 40여년간 천문학도의 길을 걸은 셈이다. 나는 그 여정의 길을 회고하면서 그 길에서 만든 조그마한 작품들을 소개하고자 한다.

[초 IT-03] Supernova, radiation, and what now for realistic galaxy formation?

Taysun Kimm (김태선)
Yonsei University (연세대학교)

은하의 형성 과정은 천체물리학의 오랜 난제다. NewHorizon, Illustris-TNG, FIRE 등 다양한 수치실험이 사실적인 은하의 모습을 재현하고자 상상 이상의 노력을 해왔고, 일부 물리적 특성을 구현함으로써 희망적인 메세지도 주었다. 그러나 은하의 진화를 결정하는 핵심 물리과정들에 대한 이해는 여전히 불만족스럽다. 시대를 달리하며 유행처럼 제시된 중력 충격파, 초신성, 그리고 복사 피드백 과정 모두 사실적인 은하를 재현하는 데 안정적으로 작용하지 않는 것처럼 보인다. 이 발표에서는 교착상태에 빠진 듯한 현 상황을 타개하기 위해 우리 연구팀이 최근 시작한 수치실험들을 소개하고, 이론 모델의 문제점을 파악하기 위해 주시하고 있는 은하의 관측적 특성에 대해 이야기 해보고자 한다.

[초 IT-04] The Double Asteroid Redirection Test: NASA's First Planetary Defense Test Mission

Andrew S. Rivkin
DART Investigation Team Lead
Johns Hopkins University Applied Physics Laboratory

The Double Asteroid Redirection Test (DART) is NASA's first planetary defense test mission, designed to test the kinetic deflector technique by crashing into an asteroid and changing its orbit. DART's launch window opens in November, 2021, with arrival at its target less than a year later in late September or early October 2022. The target of the DART spacecraft is the moonlet Dimorphos, a 150-m moonlet orbiting the 780-m asteroid Dimorphos. By changing the orbit of Dimorphos around Didymos, the results can be detected much more easily than changing the orbit of an asteroid around the Sun. I will discuss what we know about Didymos and Dimorphos, the plans for the DART mission, the expected results, and how DART is important for planetary defense in general.

[초 IT-05] Solar motion described in the Richan lili(日躔曆理), the Rìchán bùfǎ(日躔步法) and the Richan biao(日躔表) of the Yōngzhèng reign treatises on Calendrical Astronomy, Lixiang kaocheng houbian(曆象考成後編)
(《역상고성후편》의 <일전역리>, <일전보법>, <일전표>에 기록된 태양의 운동)

Seung-Urn choe[1,2], Min-Jeong Kang[3], Seulki Kim[1], Sukjoo Kim[4], Wonmo Suh[5], Jinhyon Lee[6], Yong Bok Lee[2], Myon U Lee[7], Hong-Jin Yang[8]
[1]*Seoul national University,*
[2]*Sohnam Institute for History of Astronomy*
[3]*Institute for the Translation of Korean Classics*
[4]*Anyang University*
[5]*Presbyterian University and Theological Seminary*
[6]*Graduate School of Theology, Sogang University*
[7]*Chuncheon National University of Education,*
Sohnam Institute for History of Astronomy
[8]*Korea Astronomy and Space Science Institute*

'역상고성'은 '신법산서'에 수록되어 있는 티코브라헤의 역법체계와 그 밖의 천문 내용들을 중국인 천문학자들에 의하여 확실하게 정리를 하였지만 '역상고성'에 따른 추보는 천상과 불일치를 보게 되었다. 藪內淸(야부우치 키요시) 저(1969), 유경로 역(1985)에 의하면 이러한 불일치는 옹정 8년 6월 초 1일의 일식이었는데 예보의 오류를 정정한다는 것을 중국 천문학자들이 감당하기 어려웠다. 퀘글러(Ignatius Kögler, 戴進賢, 1680~1746)와 페레이라(Andreas Pereira, 서무덕(徐懋德), 1690 - 1743) 등의 선교사 천문학자들이 칙명을 받아 종사하게 되고, 이들이 중심이 되어 '역상고성'보다 더 진보된 서양천문 역법에 기초를 둔 역서가 편찬되게 되었다.

'신법산서'와 '역상고성'은 모델에서는 평원(平圓)을 사용하지만 '역상고성후편'에서는 타원(楕圓) 모델을 사용하게 된다. 건륭 7년(1742년)에 10권이 완성되어 '역상고성후편'이라 명하였다. 타원모델을 채택하였지만 지동설에 대한 내용은 전혀 기술되어 있지 않다. 아마도 태양이나 달의 운동을 추보하는데 지구를 중심으로 해야 하기에 이에 대한 언급을 필요치 않았을 수도 있다. '역상고성후편'은 태양과 달의 운행, 일식과 월식에 대해서만 다루고 있다.

그러나 '역상고성'에서는 청몽기차나 지반경차를 티코브라헤의 표 값을 그대로 사용하였고, 이 값들이 관측과 관련이 되어 있음을 설명하려는 무리를 두고 있다. 너무 정확하게 값들이 관측 값들로부터 유도되어 의심이 갈 정도이다. 카시니(Giovanni Domenico Cassini, 喝西尼, 1625~1712)는 자신의 동료 리세와 함께 파리와 프랑스령 기아나 카이엔에서 충의 위치에 있는 화성과 부근 별의 고도를 관측하여 충의 위치에 있는 화성의 시차를 측정하여 최초로 태양과 지구 사이의 거리를 어림하고, 태양의 지반경차를 현재와 값과 거의 비슷하게 얻었다. '역상고성후편'에서는 이 내용을 상세하게 다루고 있다. 또한 대기에서 입사각과 굴절각 사이에 Snell의 법칙이 성립하는데 이를 이용하여 모호하게 알았던 청몽기차를 대기의 굴절을 이용하여 현재의 값과 비슷한 값을 얻어 사용할 수 있게 되었다. 이는 모든 천체의 위치를 관측하는데 있어서 매우 정확한 값들을 얻을 수 있게 되고 이에 따라 황도-적도 경사각도 정확하게 얻어진다. '역상고성후편'은 옹정원년을 역원으로 하고 있다.

태양의 운행에 있어서 케플러의 타원 궤도를 이용하게 된다. '신법산서'와 '역상고성'에서는 평균근점이각 M을 모델에서 보여 줄 수 있지만 타원 궤도에서는 이 각이 면적각으로 주어지고, 원 대신 타원을 다루기에 쉽지 않다. 현재는 케플러 방정식을 풀어 가감차를 구하게 되는데 이를 기하학적으로 풀이하는 차적구적법을 소개하고 있다. 이와 함께 면적을 이용하여 타원계각과 타원차각을 구하는 차각구각법도 소개한다. 타원계각과 타원차각을 모두 고려하였기에 현재의 태양의 운동을 기술하는 타원모델과 완벽하게 같다. 다만 사용하는 상수가 아주 조금 다를 분이다. 태양의 경도를 추보하는 방법도 동지점을 기준으로 하고 현재의 방법과 동일하다. 달의 운행도 타원 궤도를 사용한다.

'역상고성후편'의 내용은 우리나라의 전해져서 1860년 남병길이 쓴 '시헌기요(時憲紀要)'에는 태양, 달, 일·월식, 오행성의 운동, 항성의 위치, 시간 등을 추보하는데 필요한 내용들이 매뉴얼화 되어 기록되어 있고, 1862년 남병철이 쓴 '추보속해(推步續解)'에도 같은 내용을 담고 있다.

성간물질 및 은하

[구 IS-01] Multiepoch Optical Images of IRC+10216 Tell about the Central Star and the Adjacent Environment

Hyosun Kim[1,2], Ho-Gyu Lee[1], Youichi Ohyama[2], Ji Hoon Kim[3,4], Peter Scicluna[2,5], You-Hua Chu[2], Nicolas Mauron[6], Toshiya Ueta[7]
[1]*KASI,* [2]*ASIAA,* [3]*NAOJ,* [4]*METASPACE,* [5]*ESO,* [6]*Univ. de Montpellier and CNRS,* [7]*Univ. of Denver*

Six images of IRC+10216 taken by the Hubble Space Telescope at three epochs in 2001, 2011, and 2016 are compared in the rest frame of the central carbon star. An accurate astrometry has been achieved with the help of Gaia Data Release 2. The positions of the carbon star in the individual epochs are determined using its known proper motion, defining the rest frame of the star. In 2016, a local brightness peak with compact and red nature is detected at the stellar position. A comparison of the color maps between 2016 and 2011 epochs reveals that the reddest spot moved along with the star, suggesting a possibility of its being the dusty material surrounding the carbon star. Relatively red, ambient region is distributed in an Ω shape and well corresponds to the dusty disk previously suggested based on near-infrared polarization observations. In a larger scale, differential proper motion of multiple ring-like pattern in the rest frame of the star is used to derive the average expansion velocity of transverse wind components, resulting in ~12.5 km s-1 (d/123 pc), where d is the distance to IRC+10216. Three dimensional geometry is implied from its comparison with the line-of-sight wind velocity determined from half-widths of submillimeter emission line profiles of abundant molecules. Uneven temporal variations in brightness for different searchlight beams and anisotropic distribution of extended halo are revisited in the

context of the stellar light illumination through a porous envelope with postulated longer-term variations for a period of 10 years.

[구 IS-02] Role of Mass Inflow and Supernova Feedback on Nuclear Ring Star Formation

Sanghyuk Moon[1], Woong-Tae Kim[1], Chang-Goo Kim[2], and Eve C. Ostriker[2]
[1]Department of Physics & Astronomy, Seoul National University, [2]Department of Astrophysical Sciences, Princeton University

Observations suggest the star formation in nuclear rings of barred galaxies proceeds episodically in time and sometimes asymmetrically in space. Existing theories and numerical simulations suggest that the episodic star formation is perhaps due to either supernova feedback combined with fluid instabilities or time-varying mass inflow rate. However, it has been challenging to discern what dominates in shaping the star formation history because the effects of the inflow and feedback are blended in global simulations of nuclear rings. To understand their effects separately, we construct semi-global models of nuclear rings, which treat the mass inflow rate as a model parameter. By running simulations with the inflow rates kept constant or oscillating in time, we find that the star formation rate (SFR) of the rings varies coherently with the inflow rate, while the feedback is responsible only for stochastic fluctuations of the SFR within a factor of two. The feedback instead plays an important role in maintaining the vertical dynamical equilibrium and setting the depletion time. While the asymmetry in the inflow does not necessarily lead to the asymmetry in the star formation, we find that the rings undergo a transient period of lopsided star formation when the inflow rate of only one dust lane is suddenly increased.

[박 IS-03] TRAO-TIMES: Investigating Turbulence and Chemistry in Two Star-forming Molecular clouds

Hyeong-Sik Yun[1], Jeong-Eun Lee[1], Yunhee Choi[2], Neal J. Evans II[2,3], Stella S. R. Offner[3], Giseon Baek[1], Yong-Hee Lee[1], Minho Choi[2], Hyunwoo Kang[2], Jungyeon Cho[4], Seokho Lee[5], Ken'ichi Tatematsu[5], Mark H. Heyer[6], Brandt A. L. Gaches[7], Yao-Lun Yang[8]
[1]School of Space Research, Kyung Hee University, Republic of Korea, [2]Korea Astronomy and Space Science Institute, Republic of Korea, [3]Department of Astronomy, University of Texas, Austin, USA, [4]Department of Astronomy and Space Science, Chungnam National University, Republic of Korea, [5]National Astronomical Observatory of Japan, Japan, [6]Department of Astronomy, University of Massachusetts, Amherst, USA, [7]Center of Planetary Systems Habitability, University of Texas, Austin, USA, [8]Department of Astronomy, University of Virginia, Charlottesville, USA

Turbulence produces the density and velocity fluctuations in molecular clouds, and dense regions within the density fluctuation are the birthplace of stars. Also, turbulence can produce non-thermal pressure against gravity. Thus, turbulence plays a crucial roles in controlling star formation. However, despite many years of study, the detailed relation between turbulence and star formation remain poorly understood. As part of the Taeduk Radio Astronomy Observatory (TRAO) Key Science Program (KSP), "mapping Turbulent properties In star-forming MolEcular clouds down to the Sonic scale (TIMES; PI: Jeong-Eun Lee)", we mapped two star-forming molecular clouds, the Orion A and the ρ Ophiuchus molecular clouds, in six molecular lines (^{13}CO 1-0/C^{18}O 1-0, HCN 1-0/HCO$^+$ 1-0, and CS 2-1/N$_2$H$^+$ 1-0) using the TRAO 14-m telescope. We applied the Principal Component Analysis (PCA) to the observed data in two different ways. The first method is analyzing the variation of line intensities in velocity space to evaluate the velocity power spectrum of underlying turbulence. We investigated the relation between the star formation activities and properties of turbulence. The other method is analyzing the variation of the integrated intensities between the molecular lines to find the characteristic correlation between them. We found that the HCN, HCO$^+$, and CS lines well correlate with each other in the integral shaped filament in the Orion A cloud, while the HCO$^+$ line is anti-correlate with the HCN and CS lines in L1688 of the Ophiuchus cloud.

[구 IS-04] Complex organic molecules detected in twelve high mass star forming regions with ALMA

Giseon Baek[1], Jeong-Eun Lee[1], Tomoya Hirota[2], Kee-Tae Kim[3] and KaVA Star-Formation Science Working Group
[1]School of Space Research, Kyung Hee University, 1732, Deogyeong-daero, Giheung-gu, Yongin-si, Gyeonggi-do, 17104, Korea
[2]Department of Astronomical Sciences, SOKENDAI (The Graduate University for Advanced Studies), Osawa 2-21-1, Mitaka-shi, Tokyo 181-8588, Japan
[3]Korea Astronomy and Space Science Institute, 776

Daedeok-daero, Yuseong, Daejeon 34055, Korea

One of the key questions on star formation is how the organic molecules are synthesized and delivered to the planets and comets since they are the building blocks of prebiotic molecules such as amino acid, which is thought to contribute to bringing life on Earth. Recent astrochemical models and experiments have explained that complex organic molecules (COMs; molecules composed of six or more atoms) are produced on the dust grain mantles in cold and dense gas in prestellar cores. However, the chemical networks and the roles of physical conditions on chemistry are not still understood well. To address this question, hot (> 100 K) cores in high mass young stellar objects (M > 8 Msun) are great laboratories due to their strong emissions and larger samples than those of low-mass counterparts. In addition, CH_3OH masers, which have been mostly found in high mass star forming regions, can provide constraints due to their very unique emerging mechanisms. We investigate twelve high mass star forming regions in ALMA band 6 observation. They are associated with 44/95 GHz Class I and 6.7 GHz Class II CH3OH masers, implying that the active accretion processes are ongoing. For these previously unresolved regions, 66 continuum peaks are detected. Among them, we found 28 cores emitting COMs and specified 10 cores associated with 6.7 GHz Class II CH3OH masers. The chemical diversity of COMs is found in cores in terms of richness and complexity; we identified up to 19 COMs including oxygen- and nitrogen-bearing molecules and their isotopologues in a core. Oxygen-bearing molecules appear to be abundant and more complex than nitrogen-bearing species. On the other hand, the COMs detection rate steeply grows with the gas column density, which can be attributed to the effective COMs formation in dense cores.

[구 IS-05] Physical modeling of dust polarization spectrum by RAT alignment and disruption

Hyeseung Lee[1,2], Thiem Hoang[2]
[1]*Ulsan National Institute of Science and Technology*
[2]*Korea Astronomy & Space Science Institute*

Dust polarization depends on the physical and mechanical properties of dust, as well as the properties of local environments. To understand how dust polarization varies with grain mechanical properties and the local environment, in this paper, we model the wavelength-dependence polarization of starlight and polarized dust emission by aligned grains by simultaneously taking into account grain alignment and rotational disruption by radiative torques (RATs). We explore a wide range of the local radiation field and grain mechanical properties characterized by tensile strength. We find that the maximum polarization and the peak wavelength shift to shorter wavelengths as the radiation strength U increases due to the enhanced alignment of small grains. Grain rotational disruption by RATs tends to decrease the optical-near infrared polarization but increases the ultraviolet polarization of starlight due to the conversion of large grains into smaller ones. In particular, we find that the submillimeter (submm) polarization degree at 850μm(P850) does not increase monotonically with the radiation strength or grain temperature (Td), but it depends on the tensile strength of grain materials. Our physical model of dust polarization can be tested with observations toward star-forming regions or molecular clouds irradiated by a nearby star, which have higher radiation intensity than the average interstellar radiation field. Finally, we compare our predictions of the P850-Td relationship with Planck data and find that the observed decrease of P850 with Td can be explained when grain disruption by RATs is accounted for, suggesting that interstellar grains unlikely to have a compact structure but perhaps a composite one. The variation of the submm polarization with U (or Td)can provide a valuable constraint on the internal structures of cosmic dust

[박 IS-06] GG Tauri A: gas properties and dynamics from the cavity to the outer disk

Nguyen Thi Phuong[1,2,3], Anne Dutrey[3], Pham Ngoc Diep[1], Edwige Chapillon[3,4], Stephane Guilloteau[3], Chang Won Lee[1,5], Emmanuel Di Folco[3], Liton Majumdar[6], Jeff Bary[7], Tracy L. Beck[8], Audrey Coutens[9], Otoniel Denis-Alpizar[10], Jean-Paul Melisse[3,4], Vincent Pietu[4], Thierry Stoecklin[11], and Yei-Wen Tang[12]
[1]*Korea Astronomy and Space Science Institute, 776 Daedeokdae-ro, Yuseong-gu, Daejeon, Korea;★tpnguyen@kasi.re.kr*
[2]*Department of Astrophysics, Vietnam National Space Center, Vietnam Academy of Science and Techonology, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam*
[3]*Laboratoire d'Astrophysique de Bordeaux, Université de Bordeaux, CNRS, B18N, Allée Geoffroy Saint-Hilaire, F-33615 Pessac*
[4]*IRAM, 300 rue de la piscine, F-38406 Saint Martin d'Hères Cedex, France*
[5]*University of Science and Technology, 217 Gajeong-ro, Yuseong-gu, Daejeon 34113, Republic*

of Korea
[6]School of Earth and Planetary Sciences, National Institute of Science Education and Research, HBNI, Jatni 752050, Odisha, India
[7]Department of Physics and Astronomy, Colgate University, 13 Oak Drive, Hamilton, New York 13346, USA
[8]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, Maryland 21218, USA
[9]Institut de Recherche en Astrophysique et Planétologie, Université de Toulouse, UPS-OMP, CNRS, CNES, 9 av. du Colonel Roche, 31028 Toulouse Cedex 4, France
[10]Instituto de Ciencias Quîmicas Aplicadas, Facultad de Ingenierîa, Universidad Autónoma de Chile, Av. Pedro de Valdivia 425, 7500912 Providencia, Santiago, Chile
[11]Institut des Sciences Moléculaires, UMR5255-CNRS, 351 Cours de la libration, F-33405 Talence France
[12]Academia Sinica Institute of Astronomy and Astrophysics, PO Box 23-141, Taipei 106, Taiwan

I will presents the analysis of the gas properties of the protoplanetary disk surrounding the young low-mass (about $1.2M_{sun}$) triple star, GG Tau A. This work makes use of ALMA observations of rotational lines of CO (^{12}CO, ^{13}CO and $C^{18}O$) together NOEMA observations of a few dozens of other molecules.

While the CO emission gives information on the molecular layer close to the disk atmosphere, its less abundant isotopologues ^{13}CO and $C^{18}O$ bring information much deeper in the molecular layer.

I will present the analysis of the morphology and kinematics of the gas disk using the CO isotopologues. A radiative transfer model of the ring in CO isotopologues will also be presented. The subtraction of this model from the original data reveals the weak emission of the molecular gas lying inside the cavity. Thus, I am able to evaluate the properties of the gas inside the cavity, such as the gas dynamics, excitation conditions, and the amount of mass in the cavity. High angular resolution observations of CO reveals sprials induced by embedded planet(s) located near the 3:2:1 mean-motion resonance that help to explain the special morphology of the circumbinary disk. I also discuss some chemical properties of the GG Tau A disk. I report the first detection of H2S and C_2S in a protoplanetary disk. The molecule abundance relative to ^{13}CO of about twenties other molecules will also be given. In GG Tau A, the detections of rare molecules such as H_2S and C_2S have been probably possible because the disk is more massive (a factor about 3-5) than other disks where the molecules was searched. Such a large disk mass makes the system suitable to detect rare molecules and to study cold-chemistry in protoplanetary disks.

[박 IS-07] Study of Active Galactic Nuclei and Gravitational Wave Sources with Time-series Observation

Joonho Kim[1,2], Myungshin Im[1]
[1]Department of Physics and Astronomy, Seoul National University, Gwanak-gu, Seoul 08826, Korea
[2]Korea Astronomy and Space Science Institute, Daejeon 34055, Korea

In this presentation, study of the energetic astronomical phenomena, active galactic nucleus (AGN) and gravitational wave (GW) source, with time-series observation will be reported. They emit large amounts of energy and play an important role in the history of the Universe. First, intra-night variability of AGNs is studied using Korea Microlensing Telescope Network (KMTNet). Second topic is photometric reverberation mapping which is applied for 11 AGNs with medium-bands and Lee Sang Gak Telescope. Last, three gravitational wave events were followed-up by various optical telescopes. Each topic will be specifically addressed in the presentation.

외부은하 / 은하단 / 우주론

[구 GS-01] FR-II radio jets and the acceleration of UHECRs

Jeongbhin Seo[1], Hyesung Kang[1], Dongsu Ryu[2]
[1]Pusan National University, [2]Ulsan Institute of Science and Technology

To investigate the acceleration of ultra-high energy cosmic rays (UHECRs) in relativistic jets of FR-II galaxies, we simulate high-power jets with jet powers of Q~10^46erg/s in a stratified galaxy cluster halo using a state-of-art relativistic hydrodynamic (RHD) code we have recently developed. With the simulated jet-induced flow profiles, we then perform Monte-Carlo simulations, where the transport of high-energy particles is followed assuming large-angle scatterings in the flow-rest frame. We estimate the energy gains and acceleration times in the acceleration processes by shocks, shear, and turbulence. We present the results and discuss implications on the acceleration of UHECRs in FR II radio jets.

[구 GS-02] Faraday Rotation Measure and

Cosmic Magnetic Field

Hyunjin Cho[1], Dongsu Ryu[1], Ji-hoon Ha[1], Hyesung Kang[2]
[1]*Ulsan National Institute of Science and Technology (UNIST), Korea*
[2]*Pusan National University, Korea*

The Faraday rotation measure (RM) of extragalactic radio sources is one of tools that can explore the magnetic field in the cosmic web. We have investigated the statistical properties of the RM using the data of simulations for the large-scale structure formation of the universe. Various modelings for the cosmic magnetic field including the redshift dependence, and the intrinsic RM of radio sources have been considered. We here present the structure functions (SFs) of simulated RMs for small angular separations, and compare the SFs with observations, specifically those from the NRAO VLA Sky Survey (NVSS) and LOFAR Two-Metre Sky Survey (LoTSS). We then discuss the implications of our work.

[박 GC-03] Radiative Transfer in Highly Thick Media through Rayleigh and Raman Scattering with Atomic Hydrogen

Seok-Jun Chang
Sejong University

Hydrogen is the most abundant element in the universe, which is, in the cosmological context, attributed to its simplest structure consisting of a proton and an electron. Hydrogen interacts with an electromagnetic wave in astrophysical environments. Rayleigh scattering refers to elastic scattering, where the frequencies of the incident and scattered photons are the same. Rayleigh and resonance scattering is a critical role study Lyman Alpha objects in the early universe. The scattering causes the frequency and spatial diffusion of Lyα. In the case of Raman scattering, the energies of the incident and scattered photons are different. The photons near Lyβ convert to the optical photons near Hα through Raman scattering. The photon scattered by atomic hydrogen can carry both of the properties of the H I region and the emission region. I adopt a Monte Carlo approach to investigate the formation of the various spectral line features through Rayleigh and Raman scattering in highly thick media of atomic hydrogen. In this thesis, I present my works on radiative transfer involving the scattering processes between far UV photon and atomic hydrogen. I introduce scattering processes with atomic hydrogen and the spectral, spatial, and polarized information originating from the scattering.

[구 GC-04] Testing delayed AGN feedback using star formation rate measurements by SED fitting with JCMT/SCUBA-2 data

Changseok Kim[1], Yashashree Jadhav[1], Jong-Hak Woo[1,2], Aeree Chung[3], Junhyun Baek[3], Jeong Ae Lee[1], Jaejin Shin[1, 4], Ho Seong Hwang[1,2], Rongxin Luo[1], Donghoon Son[1], Hyungi Kim[1], Hyuk Woo[1]
[1]*Astronomy Program, Department of physics and Astronomy, Seoul National University*
[2]*SNU Astronomy Research Center, Seoul National University*
[3]*Department of Astronomy, Yonsei University*
[4]*Department of Astronomy and Atmospheric Sciences, Kyungpook National University*

The impact of AGN on star formation is one of the main questions in AGN-galaxy coevolution studies. However, direct evidence of AGN feedback is still rare. One of the main obstacles is that various star formation rate (SFR) indicators are contaminated by AGN contribution. We present IR-based SFR measurements of a sample of 52 local ($z<0.3$) AGNs, which were selected based on kinematical properties of ionized gas outflows, using SED analysis with JCMT/SCUBA-2 data. First, we will compare IR-based SFR with other SFR indicators to check the reliability of the SFR indicators. Second, we will discuss the contribution of Mid-IR emission from hot dust of AGN torus by comparing SED fitting results with and without including AGN dust component. Finally, we will report the correlation between specific SFR (sSFR) and AGN activity (e.g., outflow strength or Eddington ratio) as evidence of no instantaneous feedback and discuss the implications of these results

[구 GC-05] Preparing for low-surface-brightness science with the Rubin Observatory: characterisation of LSB tidal features from mock images

Garreth W. Martin[1,2]
[1]*KASI,* [2]*University of Arizona*

Minor mergers leave behind long lived, but extremely faint and extended tidal features including tails, streams, loops and plumes. These act as a fossil record for the host galaxy's past interactions, allowing us to infer recent accretion histories and place constraints on the properties and nature of a galaxy's dark matter halo. However, shallow imaging or small homogeneous samples of past surveys have resulted in weak

observational constraints on the role of galaxy mergers and interactions in galaxy assembly. The Rubin Observatory, which is optimised to deliver fast, wide field-of-view imaging, will enable deep and unbiased observations over the 18,000 square degrees of the Legacy Survey of Space and Time (LSST), resulting in samples of potentially of millions of objects undergoing tidal interactions.

Using realistic mock images produced with state-of-the-art cosmological simulations we perform a comprehensive theoretical investigation of the extended diffuse light around galaxies and galaxy groups down to low stellar mass densities. We consider the nature, frequency and visibility of tidal features and debris across a range of environments and stellar masses as well as their reliability as an indicator of galaxy accretion histories. We consider how observational biases such as projection effects, the point-spread-function and survey depth may effect the proper characterisation and measurement of tidal features, finding that LSST will be capable of recovering much of the flux found in the outskirts of L* galaxies at redshifts beyond local volume. In our simulated sample, tidal features are ubiquitous In L* galaxies and remain common even at significantly lower masses (M*>10^10 Msun). The fraction of stellar mass found in tidal features increases towards higher masses, rising to 5-10% for the most massive objects in our sample (M* ~10^11.5 Msun). Such objects frequently exhibit many distinct tidal features often with complex morphologies, becoming increasingly numerous with increased depth. The interpretation and characterisation of such features can vary significantly with orientation and imaging depth. Our findings demonstrate the importance of accounting for the biases that arise from projection effects and surface-brightness limits and suggest that, even after the LSST is complete, much of the discovery space in low surface-brightness Universe will remain to be explored.

[구 GC-06] Probing neutral gas clouds and associated galaxies in the early universe

Adarsh Ranjan, FRAS
Korea Astronomy and Space Science Institute

Neutral (HI) gas clouds associated with galaxies are responsible for fuelling the star-formation in the universe. In literature, the extremely strong damped Lyman-alpha absorbers (or ESDLAs) have been known to be sensitive to the effects of HI-H2 transition and star-formation in galaxies. Yet, ESDLAs are rare to probe due to the smaller cross section they subtend on the sky (similar to galaxies).

In my talk, I will focus primarily on my study of the nature of ESDLAs that are observed as absorption signature along the line-of-sight (LOS) of a quasar (QSO). I will further look at the HI-H2 transition and interesting results relevant to diffuse molecular gas and the multi-phase medium (gas in different ionization states) that are associated with ESDLAs.

Furthermore, I will also discuss how the ESDLA environments differ from the high star-forming and molecular environments detected in blind optical and radio surveys consecutively.

[구 GC-07] Tracing the first galaxies with the James Webb Space Telescope

Sandro Tacchella
Department of Physics, Ulsan National Institute of Science and Technology (UNIST), Ulsan 44919

I will start with presenting new results on the stellar populations of galaxies at a redshift of z=9-11, when the universe was only a few hundred million years old. By combining Hubble Space Telescope observations with Spitzer imaging data, I will show how challenging it is currently to measure basic physical properties of these objects such as star-formation rates, stellar masses and stellar ages. In particular, the current measurements greatly depend on the assumptions (priors) for the spectral energy distribution modeling. Finally, I will discuss how the James Webb Space Telescope (JWST) will revolutionize this field next year and allow us to probe and characterize the first generation of galaxies in much greater detail. Specifically, I will present an overview of the JWST Advanced Deep Extragalactic Survey (JADES), a joint program of the JWST/NIRCam and NIRSpec Guaranteed Time Observations (GTO) teams involving 950 hours of observation.

[구 GC-08] Large Scale Distribution of Globular Clusters in the Coma Cluster

Seong-A O, Myung Gyoon Lee
Astronomy program, Department of Physics and Astronomy, Seoul National University

Coma cluster (Abell 1656) is one of the most massive local galaxy clusters such as Virgo, Fornax, and Perseus, which holds a large collection of globular clusters. Globular cluster systems (GCSs) in a galaxy cluster tell us a history of hierarchical cluster assembly and intracluster GCs (ICGCs) are known to trace the gravitational potential of the galaxy cluster.

Previous studies of GCSs in Coma mainly utilized data obtained using Hubble Space Telescope (HST) with high spatial resolution. However, most of the data were based on narrow-field pointing observations. In this study we present the widest survey of GCSs in the Coma cluster using the archival Subaru/Hyper Suprime-Cam (HSC) *g* and *r* images, supplemented with the archival HST images.

The Coma GCSs are largely extended in E-W and SW direction, along the general direction of Coma-Abell 1367 filament. This global structure of the GCSs is consistent with the spatial distribution of the intracluster light (ICL).

ICGC spatial distribution is largely extended to almost ~50% of the virial radius. Most of these ICGCs are blue and metal-poor, which supports the scenario that ICGCs are mainly originated from dwarf galaxies and some proportion from brighter galaxies. Implications of the results will be discussed.

[구 GC-09] Galaxy identification with the 6D friends-of-friend algorithm for high resolution simulations of galaxy formation

Jinsu, Rhee[1], Pascal, Elahi[2], and Sukyoung, K. Yi[1]
[1]Department of Astronomy and Yonsei University Observatory, Yonsei University, Seoul 03722, Korea, [2]International Centre for Radio Astronomy Research, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia

Galaxy/Halo finding based on the friends-of-friend (FoF) algorithm has been widely adopted for its simplicity and expandability to the phase-space. However, cosmological simulations have been progressively bigger in size and more accurate in resolutions, resulting in that galaxy/halo finding gets computationally expensive more and more. In fact, we confirm this issue through our exercise of applying the 6-dimensional (6D) FoF galaxy finder code, VELOCIraptor (Elahi et al.2019) on the NewHorizon simulation (Dubois et al. 2021), in which typical galaxies with about 1e11 M_{sun} (10^7 particles) are identified with very low speed (longer than a day). We have applied several improvements to the original VELOCIraptor code that solve the low-performance problem of galaxy finding on a simulation with high resolutions. Our modifications find the exact same FoF group and can be readily applied to any tree-based FoF code, achieving a 2700 (12) times speedup in the 3D (6D) FoF search compared to the original execution. We applied the updated version of VELOCIraptor on the entire NewHorizon simulation (834 snapshots) and identified its galaxies and halos. We present several quick comparisons of galaxy properties with those with GALAXYMaker data.

[구 GC-10] Probing Intracluster Light of 10 Galaxy Clustersat z >1 with Deep HST WFC3/IR Imaging Data

Hyungjin. Joo[1], M. James. Jee[1,2], Jongwan Ko[3,4]
[1]Departmentof Astronomy, Yonsei University, 50 Yonsei-ro, Seoul 03722, Korea, [2]Departmentof Physics, University of California, Davis, One Shields Avenue, Davis, CA95616, USA, [3]Korea Astronomy and Space Science Institute, Daedeokdae-ro, Daejeon 34055, Republic of Korea, [4]University of Science andTechnology, Gajeong-ro, Daejeon 34113, Republic of Korea

Intraclusterlight (ICL) is diffuse light from stars that are bound to the clusterpotential, not to individual member galaxies. Understanding the formationmechanism of ICL provides critical information on the assembly and evolution ofthe galaxy cluster. Although there exist several competing models, the dominantproduction mechanism is still in dispute. The ICL measurement between z=1 and 2strongly constrains the formation scenario of the ICL because the epoch is whenthe first mature clusters begin to appear. However, the number of high-redshiftICL studies is small mainly because of observational challenges. In this study,based on deep HST WFC3/IR data, we measured ICL of 10 galaxy clusters atredshift beyond unity, which nearly doubles the sample size in this redshiftregime. With careful handling of systematics including object masking, skyestimation, flatfielding, dwarf galaxy contamination, etc., we quantified thetotal amount of ICL, measured the color profile, and examined the transitionbetween BCG and ICL.

[구 GC-11] A tale of two cities: Two galaxy clusters at cosmic noon

Seong-Kook Lee[1], Myungshin Im[1], Bomi Park[1], Minhee Hyun[2], Insu Paek[1] et al.
[1]Seoul National University, [2]Korea Astronomy and Space Science Institute,

At high redshift, unlike local, many galaxy clusters are still at their stages of building. Likewise, they show a wide range in their star formation properties: some are still forming stars actively unlike their local counterparts, while others have very low level of star formation already. Here we report the two high-redshift (z~1) galaxy clusters, confirmed via Magellan MOS observation. While existing at similar redshift and having similar mass, these two clusters show very

different quiescent galaxy fraction. The origin of this difference is investigated, and will be presented in the presentation.

[구 GC-12] Measuring the Environmental Quenching Timescales of Galaxy Clusters in the COSMOS field

Eunhee Ko[1], Myungshin Im[1], Seong-Kook Lee[1], Insu Paek[1] ,and Bomi Park[1]
[1]Astronomy program, Dept. of Physics & Astronomy, Seoul National University

Using 74 galaxy clusters in the COSMOS field at 0.1 < z < 1.2, we calculate the environmental quenching timescale, defined as the time required after a galaxy is accreted by a cluster for it to stop star formation. Cluster candidates are selected as the overdensities with the surface number density exceeding the 4-σ. With the "delayed-then-rapid" quenching model, we can successfully reproduce the separation of the galaxies(star-forming, intermediate, and quiescent) on the NUV-R - R-J color plane comparing with the BC03 evolutionary track. With the mass growth rate of halo mass and the ratio of categorized galaxies, we can constratin the environmental quenching timescale ~ 2Gyr at z ~ 1. We will present the result as a function of redshift and compare them with dynamical timescale and gas depletion timescale.

[구 GC-13] Mapping the Star Formation Activity of Five Jellyfish Galaxies in Massive Galaxy Clusters with GMOS/IFU

Jeong Hwan Lee[1], Myung Gyoon Lee[1], Jae Yeon Mun[2]
[1]Seoul National University,
[2]Australian National University

Ram-pressure stripping (RPS) is known as the main driver of quenching the star formation (SF) activity in cluster galaxies. However, galaxies undergoing RPS in galaxy clusters often show blue star-forming knots in their disturbed disks and tails. The existence of these “jellyfish galaxies” implies that RPS can temporarily boost the SF activity of cluster galaxies. Thus, jellyfish galaxies are very unique and interesting targets to study the influence of RPS on their SF activity, in particular with integral field spectroscopy (IFS). While there have been many IFS studies of jellyfish galaxies in low-mass clusters (e.g., the GASP survey), IFS studies of those in massive clusters have been lacking. We present an IFS study of five jellyfish galaxies in massive clusters at intermediate redshifts using the Gemini GMOS/IFU. Their star formation rates (SFRs) are estimated to be up to 15 Mo/yr in the tails and 50 Mo/yr in the disks. These SFRs are by a factor of 10 higher than those of star-forming galaxies on the main sequence in the M∗-SFR relation at similar redshifts. Our results suggest that the SF activity of jellyfish galaxies tends to be more enhanced in massive clusters than in low-mass clusters. This implies that strong RPS in massive clusters can trigger strong starbursts.

[구 GC-14] The Kaiser Rocket Effect in Cosmology

Benedict Bahr-Kalus
Korea Astronomy and Space Science Institute

The peculiar motion of the observer, if not (or only imperfectly) accounted for, is bound to induce a well-defined clustering signal in the distribution of galaxies. This spurious signal is related to the Kaiser rocket effect. We examined the amplitude of this effect and discuss possible implications for analysis and interpretation of future cosmological surveys. We found that it can in principle bias very significantly the inference of cosmological parameters, especially for primordial non-Gaussianity.

[구 GC-15] The DESI peculiar velocity survey

Christoph Saulder
Korea Astronomy and Space Science Institute

One of the most promising secondary target programmes of DESI is the peculiar velocity survey, which will notably improve the measurements of cosmology parameters in the low-redshift universe. We use the Fundamental plane and Tully-Fisher relation as distance indicators to calculate peculiar velocities for DESI. This required additional observations to obtain spectra with sufficient quality to measure the velocity dispersions in the case of the fundamental plane, and to get off-centre redshift measurements to reconstruct the rotation curve in the case of the Tully-Fisher relation. However, we devised a clever strategy for suitable target galaxies, that takes advantage of the spare fibres of DESI to gather the required additional data without causing conflicts with the main survey programmes. We provide a brief overview of the preliminary results and success rate based on the first measurements obtained during survey validation as well as an outlook on expected improvements in the $f\sigma_8$ measurements once the survey has been completed.

[구 GC-16] Cosmology with peculiar velocity

surveys

Fei Qin
Korea Astronomy and Space Science Institute

In the local Universe, the gravitational effects of mass density fluctuations exert perturbations on galaxies' redshifts on top of Hubble's Law, called 'peculiar velocities'. These peculiar velocities provide an excellent way to test the cosmological model in the nearby Universe. In this talk, we present new cosmological constraints using peculiar velocities measured with the 2MASS Tully-Fisher survey (2MTF), 6dFGS peculiar-velocity survey (6dFGSv), the Cosmicflows-3 and Cosmicflows-4TF compilation. Firstly, the dipole and the quadrupole of the peculiar velocity field, commonly named 'bulk flow' and 'shear' respectively, enable us to test whether our cosmological model accurately describes the motion of galaxies in the nearby Universe. We develop and use a new estimators that accurately preserves the error distribution of the measurements to measure these moments. In all cases, our results are consistent with the predictions of the Λ cold dark matter model. Additionally, measurements of the growth rate of structure, fσ8 in the low-redshift Universe allow us to test different gravitational models. We developed a new estimator of the "momentum" (density weighted peculiar velocity) power spectrum and use joint measurements of the galaxy density and momentum power spectra to place new constraints on the growth rate of structure from the combined 2MTF and 6dFGSv data. We recover a constraint of fσ8=0.404+0.082-0.081 at an effective redshift zeff=0.03. This measurement is also fully consistent with the expectations of General Relativity and the Λ Cold Dark Matter cosmological model.

[구 GC-17] High-resolution CMB bispectrum estimator for future surveys

Wuhyun Sohn (손우현)
Korea Astronomy and Space Science Institute (한국천문연구원)

The Cosmic Microwave Background (CMB) contains a wealth of information about the perturbations in the early universe. Its bispectrum, the Fourier counterpart of three-point correlation functions, is a direct probe of primordial non-Gaussianity predicted by many physically well motivated inflation models. Motivated by the substantial improvement in sensitivity expected from future CMB surveys, we developed a novel bispectrum estimator capable of handling such high-resolution data. Our code, named CMB-BEst, utilises a set of separable basis functions to constrain a wide variety of models simultaneously. Flexibility in the choice of basis enables targeted analysis on highly oscillatory inflation models, which are previously unconstrained due to the numerical and computational challenges involved. We present the results of our thorough validation tests, both internal and against conventional approaches. We provide a proof-of-concept example with Planck satellite data and sketch out the road ahead.

[구 GC-18] Identifying Lensed Quasars and measuring their Time-Delays in Unresolved Systems

Satadru Bag
Korea Astronomy and Space Science Institute

Detecting lensed quasar systems and estimating their time delays using the unresolved joint light curves can be the next frontier among the cosmological probes in the near future. One can get the independent measurement of the Hubble constant from the time delays but without requiring the systems to be resolved a priori followed by monitoring the image light curves using high-resolution telescopes for years. In this work, we propose a novel technique that can identify lensed quasars only using the observed unresolved light curves and without assuming a template or any prior information. Following a set of conservative selection criteria that gives zero false-positive outcome, we can accurately estimate the time delay for almost all the lensed systems with marginal noise in the data. For the case of noisy data, our approach can still correctly identify a substantial number of lensed systems with high certainty and measure the time delay accurately.

[구 GC-19] Excursion-Set Modeling of the Splashback Mass Function and its Cosmological Usefulness (Splashback 질량함수의 Excursion-Set Modeling과 우주론적 유용성)

Suho Ryu (유수호), Jounghun Lee (이정훈)
Seoul National University (서울대학교)

일반화된 excursion set 이론과 자기 유사 구형 유입 (Self-similar spherical infall) 모형에 기반하여 Splashback 질량함수에 대한 해석적 단일 매개변수 모델을 착안하였다. Planck/WMAP7 관측결과를 토대로 구축된 EREBOS N-Body 시뮬레이션의 수치적 결과의 해석적 모델을 이용한 회귀분석을 통해 단일 매개변수이자 Splashback 경계의 확산적 특성을 수치화하는 확산계수 (Diffusion Coefficient)의 추정치를 계산하였다. 계산된

확산계수를 적용한 해석적 모델과 수치적 결과가 $5 \leq M/(10^{12}h^{-1}\ M_{\odot}) < 10^{3}$의 질량범위에서 매우 근접히 일치하는 것을 보였으며 Baysian and Akaike Information Criterion 검정을 통해 $0.3 \leq z \leq 3$의 범위에서 기존의 모델들보다 본 모델이 선호 돼야함을 확인하였다. 또한 확산계수가 적색편이에 대하여 선형진화에 근접한 변화를 보임을 발견하였으며, 특정 임계 적색편이(z_c)를 기준으로 확산계수가 0에 수렴함을 발견하였다. 더 나아가 두 Planck모델과 WMAP7모델에서 도출된 확산계수는 서로 상당한 차이를 보였다. 이 결과는 암흑물질 헤일로의 splashback 질량함수가 $z \geq z_c$에서 매개변수가 없는 온전한 해석적 모델로 설명되고 z_c가 독립적으로 우주의 초기조건을 독립적으로 특정지을 수 있는 가능성을 지님을 시사한다. 이 초록은 The Astrophysical Journal의 Ryu & Lee 2021, ApJ, 917, 98 (arxiv:2103.00730) 논문을 바탕으로 작성되었다.

[구 GC-20] Horizon Run Spin-off Simulations for Studying the Formation and Expansion history of Early Universe

Yonghwi Kim[1], Jaehong Park[1], Changbom Park[1], Juhan Kim[2], Ankit Singh[1], Jaehyun Lee[1], Jihye Shin[3]
[1]Korea Institute for Advanced Study, [2]Center for Advanced Computations, Korea Institute for Advanced Study, [3]Korea Astronomy and Space Science Institute

Horizon Run 5 (HR5) is a cosmological hydrodynamical simulation which captures the properties of the Universe on aGpc scale while achieving a resolution of 1kpc. This enormous dynamic range allows us to simultaneously capture the physics of the cosmic web on very large scales and account for the formation and evolution of dwarf galaxies on much smaller scales. On the back of a remarkable achievement of this, we have finished to run follow-up simulations which have 2 times larger volume than before and are expected to complementary to some limitations of previous HR simulations both for the study on the large scale features and the expansion history in a distant Universe. For these simulations, we consider the sub-grid physics of radiative heating/cooling, reionization, star formation, SN/AGN feedbacks, chemical evolution and the growth of super-massive blackholes. In order to do this project, we implemented a hybrid MPI-OpenMP version of the RAMSES code, 'RAMSES-OMP', which is specifically designed for modern many-core many thread parallel systems. These simulation successfully reproduce various observation result and provide a large amount of statistical samples of Lyman-alpha emitters and protoclusters which are important to understand the formation and expansion history of early universe. These are invaluable assets for the interpretation of current ΛCDM cosmology and current/upcoming deep surveys of the Universe, such as the world largest narrow band imaging survey, ODIN (One-hundred-square-degree Dark energy camera Imaging in Narrow band).

[구 GC-21] Horizon Run 5 Black Hole Populations and Pulsar Timing Array

Chunglee Kim[1], Hyo Sun Park[2], Juhan Kim[3], Andrea Lommen[4]
[1]Ewha Womans University, [2]Bryn Mawr College, USA, [3]Korea Institute for Advanced Study, [4]Haverford College, USA

Merging of two supermassive black holes would generate gravitational waves that can be detected by the Pulsar Timing Array (PTA) in the nHz band. In order to assess the plausibility of GW detection with PTA and to develop the data analysis scheme, it is important to understand the underlying properties of black holes and black hole binaries. In this work, we present mass and redshift distributions of black hole mergers using the Horizon Run 5 (HR5) data and discuss their implications for GW detection. We find a general conjecture about the black hole merger tree is true with the Horizon Run 5. For example, a) relatively lighter black holes merge at higher redshifts and b) binary mergers do contribute to the formation of more massive black holes toward low redshifts. We also present our plan to use the black hole properties extracted from the HR5 data in order to generate simulated GW signals to be injected into actual PTA data analysis pipelines. Mass and distance obtained from the HR5 would be key ingredients to generate a more realistic PTA source data set.

[구 GC-22] STag: Supernova Tagging and Classification

William Davison[1,2], David Parkinson[1,2], and Brad E. Tucker[3,4,5]
[1]Korea Astronomy and Space Science Institute, 776, Daedeokdae-ro, Yuseong-gu, Daejeon 34055, Republic of Korea
[2]University of Science and Technology, 217, Gajeong-ro, Yuseong-gu, Daejeon 34113, Republic of Korea
[3]Mt Stromlo Observatory, The Research School of Astronomy and Astrophysics, Australian National University, ACT 2611, Australia
[4]National Centre for the Public Awareness of Science, Australian National University, Canberra, ACT 2601, Australia
[5]The ARC Centre of Excellence for All-Sky Astrophysics in 3 Dimension (ASTRO 3D), Australia

Supernovae classes have been defined phenomenologically, based on spectral features and time series data, since the specific details of the physics of the different explosions remain unrevealed. However, the number of these classes is increasing as objects with new features are observed, and the next generation of large-surveys will only bring more variety to our attention. We apply the machine learning technique of multi-label classification to the spectra of supernovae. By measuring the probabilities of specific features or `tags' in the supernova spectra, we can compress the information from a specific object down to that suitable for a human or database scan, without the need to directly assign to a reductive `class'. We use logistic regression to assign tag probabilities, and then a feed-forward neural network to filter the objects into the standard set of classes, based solely on the tag probabilities. We present STag, a software package that can compute these tag probabilities and make spectral classifications.

태양/태양계

[구 SS-01] F-Coronal Polarized Brightness Diagnostics using a Filter Ratio (필터비를 이용한 F코로나 편광량 측정방법)

Heesu Yang[1], Kyuhyoun Cho[2], Suchan Bong[1], Yeon-Han Kim[1], Seounghwan Choi[1]
[1]*Korea Astronomy and Space Science Institute*
[2]*Seoul National University*

태양으로부터 3Rs보다 높은 코로나 밝기의 대부분은 먼지에 의해 산란된 F코로나로부터 나온다. F코로나와 자유전자의 톰슨산란에 의한 K코로나를 분리하는 효과적인 방법은 편광을 이용하는 것으로 알려져 있고 현재 NASA와 천문연간 협력개발 중인 K코로나 관측 기기 COronal Diagnostic EXperiment(CODEX)도 편광을 이용한 분류를 기본으로 자유전자의 온도와 속도를 측정한다. 문제는 F코로나도 약간의 편광도를 가져서 K코로나와 구별이 불가능해지는데다 F코로나의 편광량은 먼지입자의 구성물질, 모양, 산란 위치 등에 따라 달라서 거의 예측이 불가능하고 지금까지 제대로 알려진 바도, 연구된 바도 없다. 우리는 CODEX에서 F코로나 편광량을 산출하기 위해 한 개의 협대역 필터(Narrow Bandpass Filter)를 추가장착하는 것을 제안하였고 그 중심파장과 밴드폭을 결정하였다. 몬테카를로 계산 결과 10장의 393.55nm 중심의 1.4nm폭 협대역필터와 393.5nm 중심의 10nm 협대역 필터비를 이용해 1Rs 화소의 해상도로 F코로나 편광량을 결정할 수 있을 것으로 예상된다. 2023년 CODEX 발사 후 본 관측이 성공적으로 수행된다면 F코로나의 편광량의 시간, 공간적 변화를 확인할 수 있으며 추가적으로 K코로나를 보다 정밀하게 분리해낼 수 있을 것으로 기대된다.

[구 SS-02] DeepSDO: Solar event detection using deep-learning-based object detection methods

Ji-Hye Baek[1,2], Sujin Kim[1], Seonghwan Choi[1], Jongyeob Park[1], Jihun Kim[1], Wonkeum Jo[2], Dongil Kim[2]
[1]*Korea Astronomy and Space Science Institute, Korea*
[2]*Chungnam National University, Korea*

We present solar event auto detection using deep-learning-based object detection algorithms and DeepSDO event dataset. DeepSDO event dataset is a new detection dataset with bounding boxed as ground-truth for three solar event (coronal holes, sunspots and prominences) features using Solar Dynamics Observatory data. To access the reliability of DeepSDO event dataset, we compared to HEK data. We train two representative object detection models, the Single Shot MultiBox Detector (SSD) and the Faster Region-based Convolutional Neural Network (R-CNN) with DeepSDO event dataset. We compared the performance of the two models for three solar events and this study demonstrates that deep learning-based object detection can successfully detect multiple types of solar events. In addition, we provide DeepSDO event dataset for further achievements event detection in solar physics.

[구 SS-03] Fast Spectral Inversion of the Strong Absorption Lines in the Solar Chromosphere Based on a Deep Learning Model

Kyoung-SunLee[1], Jongchul Chae[1], Eunsu Park[2], Yong-JaeMoon[2], Hannah Kwak[1], Kyuhyun Cho[1]
[1]*Seoul National University (서울대학교),*
[2]*Kyung Hee University (경희대학교)*

Recently a multilayer spectral inversion (MLSI) model has been proposed to infer the physical parameters of plasmas in the solar chromosphere. The inversion solves a three-layer radiative transfer model using the strong absorption line profiles, H alpha and Ca II 8542 Å, taken by the Fast Imaging Solar Spectrograph (FISS). The model successfully provides the physical plasma parameters, such as source functions, Doppler velocities, and Doppler widths in the layers of the photosphere to the chromosphere. However, it is quite expensive to apply the MLSI to a huge number of line profiles. For example, the calculating time is an hour to several hours

depending on the size of the scan raster. We apply deep neural network (DNN) to the inversion code to reduce the cost of calculating the physical parameters. We train the models using pairs of absorption line profiles from FISS and their 13 physical parameters (source functions, Doppler velocities, Doppler widths in the chromosphere, and the pre-determined parameters for the photosphere) calculated from the spectral inversion code for 49 scan rasters (~2,000,000 dataset) including quiet and active regions. We use fully connected dense layers for training the model. In addition, we utilize a skip connection to avoid a problem of vanishing gradients. We evaluate the model by comparing the pairs of absorption line profiles and their inverted physical parameters from other quiet and active regions. Our result shows that the deep learning model successfully reproduces physical parameter maps of a scan raster observation per second within 15% of mean absolute percentage error and the mean squared error of 0.3 to 0.003 depending on the parameters. Taking this advantage of high performance of the deep learning model, we plan to provide the physical parameter maps from the FISS observations to understand the chromospheric plasma conditions in various solar features.

[구 SS-04] Spectroscopic Detection of Alfvénic Waves in the Chromosphere of Sunspot Regions

Jongchul Chae[1], Kyuhyoun Cho[1], Valery M. Nakariakov[2,3], Kyung-Suk Cho[4,5] and Ryun-Young Kwon[4]
[1]Seoul National University, [2]University of Warwick [3]Kyung Hee University, [4]Korea Astronomy and Space Science Institute, [5]University of Science and Technology

Transverse magnetohydrodynamic waves often called Alfvénic (or kink) waves have been often theoretically put forward to solve the outstanding problems of the solar corona like coronal heating, solar wind acceleration, and chemical abundance enhancement. Here we report the first spectroscopic detection of Alfvénic waves around a sunspot at chromospheric heights. By analyzing the spectra of the Hα line and Ca II 854.2 nm line, we determined line-of-sight velocity and temperature as functions of position and time. As a result, we identified transverse magnetohydrodynamic waves pervading the superpenumbral fibrils. These waves are characterized by the periods of 2.5 to 4.5 minutes, and the propagation direction parallel to the fibrils, the supersonic propagation speeds of 45 to 145 km s−1, and the close association with umbral oscillations and running penumbral waves in sunspots. Our results support the notion that the chromosphere around sunspots abounds with Alfvénic waves excited by the mode conversion of the upward-propagating slow magnetoacoustic waves.

[구 SS-05] A self-consistent model for the formation and eruption of a solar prominence

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

The present study is focused on origins of the flow and magnetic structure involved in the formation and eruption of a solar prominence. To clarify them, we performed an MHD simulation based on the 3-dimensional emerging flux tube (3DEFT) model, in which self-consistent evolution of a flow and magnetic field passing freely through the solar surface was obtained by seamlessly connecting subsurface dynamics with surface dynamics. By analyzing Lagrangian displacements of magnetized plasma elements, we demonstrate the flow structure which is naturally incorporated to the magnetic structure of the prominence formed via dynamic interaction between the flow and magnetic field.

[구 SS-06] Negative Turbulent Magnetic β Diffusivity effect in a Magnetically Forced System

Park Kiwan & Cheoun Myung-Ki
Soongsil University

We studied the large scale dynamo process in a system forced by helical magnetic field. The dynamo process is basically nonlinear, but can be linearized with $\alpha\&\beta$ coefficients and large scale magnetic field $\overline{B}$. This is very useful to the investigation of solar (stellar) dynamo. A coupled semi-analytic equations based on statistical mechanics are used to investigate the exact evolution of $\alpha\&\beta$. This equation set needs only magnetic helicity $\overline{H}_M(\equiv\langle\overline{A}\cdot\overline{B}\rangle, \overline{B}=\nabla\times\overline{A})$ and magnetic energy $\overline{E}_M(\equiv\langle\overline{B}^2\rangle/2)$. They are fundamental physics quantities that can be obtained from the dynamo simulation or observation without any artificial modification or assumption. α effect is thought to be related to magnetic field amplification. However, in reality the

averaged α effect decreases very quickly without a significant contribution to $\overline{B}$ field amplification. Conversely, β effect contributing to the magnetic diffusion maintains a negative value, which plays a key role in the amplification with Laplacian $\nabla^2(=-k^2)$ for the large scale regime. In addition, negative magnetic diffusion accounts for the attenuation of plasma kinetic energy $E_V(=\langle U^2\rangle/2)$ (U: plasma velocity) when the system is saturated. The negative magnetic diffusion is from the interaction of advective term $-U \bullet \nabla B$ from magnetic induction equation and the helical velocity field. In more detail, when 'U' is divided into the poloidal component U_{pol} and toroidal one U_{tor} in the absence of reflection symmetry, they interact with $B \bullet \nabla U$ and $-U \bullet \nabla B$ from $\nabla \times \langle U \times B \rangle$ leading to α effect and (negative) β effect, respectively. We discussed this process using the theoretical method and intuitive field structure model supported by the simulation result.

[구 SS-07] Photometric study of Main-belt asteroid (298) Baptistina

Dong-Heun Kim[1,2], Myung-Jin Kim[2], Hee-Jae Lee[2], Murat Kaplan[3], Orhan Erece[3,4], Taewoo Kim[5], Joh-Na Yoon[6], Anna Marciniak[7], Hong-Kyu Moon[2], Young-Jun Choi[2,8], Yonggi Kim[1]
[1]Chungbuk National University, [2]Korea Astronomy and Space Science Institute, [3]Akdeniz Universitesi, [4]TÜBITAK National Observatory, [5]National Youth Space Center, [6]Chungbuk National University Observatory, [7]Adam Mickiewicz University, [8]University of Science and Technology

The Main-belt asteroid (298) Baptistina (hereafter 'Baptistina') is regarded as an X- (or C-) type asteroid and the largest member of the Baptistina asteroid family. Its basic physical properties play an important role in understanding the rotational evolution and orbital dynamics of the Baptistina family. In this study, we determined the physical characteristics of Baptistina from the optical observations. We conducted BVRI and R band photometric observations from 2017 to 2021 for a total of 47 nights using the 0.5 - 2.0 m-class telescopes. As a result, the color indices of Baptistina were derived as , , and ; this result is consistent with the previous classification of Baptistina as an X- (or C-) type. We also determined absolute magnitude () and slope parameter () by using a simplified version of the IAU H & G function (Bowell et al. 1989) are mag and respectively. We calculated the effective radius of Baptistina of km considering the visual geometric albedo of 0.131 from the NEOWISE data. Using the light-curve inversion method, the sidereal rotation period of 16.224235 h and the 3D shape model with a pole orientation (,) were also determined. In this presentation we will introduce our observations and results, and also discuss about the physical properties of Baptistina asteroid family members such as color indices.

[구 SS-08] Reflectance-Color Trends on the Lunar Mare Surface

Sungsoo S. Kim[1] (김성수), Chae Kyung Sim[2] (심채경)
[1]Kyung Hee University, [2]Korea Astronomy and Space Science Institute

The lunar surface progressively darkens and reddens as a result of sputtering from solar wind particles and bombardment of micrometeoroids. The extent of exposure to these space weathering agents is frequently calculated as the location in a diagram of reflectance at 750 nm vs. 950 nm/750 nm color (R-C). Sim & Kim (2018) examined the R-C trends of pixels within ~3,500 craters, and revealed that the length (*L*) and skewness (*s*) of R-C trends can be employed as a secondary age or maturity indicator. We broaden this research to general lunar surface areas (3,400 tiles of 0.25° × 0.25° size) in 218 mare basalt units, whose ages have been derived from the size-frequency distribution analysis by Hiesinger et al. (2011). We discover that *L* and *s* rise with age until ~3.2 Gyr and reduce rather rapidly afterward, while the optical maturity, OMAT, reduces monotonically with time. We show that in some situations, when not only OMAT but also *L* and *s* are incorporated in the estimation utilizing 750 & 950 nm photometry, the age estimation becomes considerably more reliable. We also observed that OMAT and the lunar cratering chronology function (cumulative number of craters larger than a certain diameter as a function of time) have a relatively linear relationship.

천문화학/천문생물학

[구 AB-01] Panspermia in a Milky Way-like Galaxy

Sungwook E. Hong (홍성욱)[2], Raphael Gobat[1,2*], Owain Snaith[3], Sungryong Hong (홍성용)[2]
[1]Pontificia Universidad Catolica de Valparaiso, [2]Korea Astronomy and Space Science Institute (한국천문연구원), [3]Observatoire de Paris

We study the process of panspermia in Milky Way-like galaxies by modeling the probability of successful travel of organic compounds between stars harboring potentially habitable planets. To this end, we apply the modified habitability recipe of Gobat & Hong (2016) to a model galaxy from the MUGS suite of zoom-in cosmological simulations. We find that, unlike habitability, which only occupies narrow dynamic range over the entire galaxy, the panspermia probability can vary be orders of magnitude between the inner (R, b = 1~4 kpc) and outer disk. However, only a small fraction of star particles have very large values of panspermia probability and, consequently, the fraction of star particles where the panspermia process is more effective than prebiotic evolution is much lower than from naïve expectations based on the ratio between panspermia probability and natural habitability.

The lunar surface progressively darkens and reddens as a result of sputtering from solar wind particles and bombardment of micrometeoroids. The extent of exposure to these space weathering agents is frequently calculated as the location in a diagram of reflectance at 750 nm

항성 및 항성계

[구 SA-01] Long-term simultaneous monitoring observations of SiO and H2O masers toward Mira variable WX Serpentis

Jang Ho Lim[1], Jaeheon Kim[2], Seong Min Son[1], Kyung-Won Suh[1], Se-Hyung Cho[2,3], Haneul Yang[2,3], and Dong-Hwan Yoon[2]
[1]*Chungbuk National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Seoul National University*

We carried out simultaneous monitoring observations of five maser lines, H2O (22 GHz), SiO v =1, 2, J =1-0 (43.1, 42.8 GHz), and SiO v =1, J =2-1, J =3-2 (86.2, 129.3 GHz), toward the Mira variable star WX Serpentis with the 21-m antennas of the Korean VLBI Network (KVN) in 2009-2021 (~ 12 years). Most spectra of the H2O maser are well separated into two parts of two blue- and one redshifted features within ± 10 km s-1 of the stellar velocity. All detected SiO masers are generally concentrated within ± 5 km s-1 of the stellar velocity, and sometimes appear split into two components. Overall, the profiles of SiO and H2O masers detected in WX Serpentis illustrate typical characteristics of the Mira variable. In addition, flux variations of both SiO and H2O masers are well correlated with the optical light curve of the central star, showing a phase lag of ~ 0.1 for SiO masers and ~ 0.2 for H2O maser. This phenomenon is considered to be the direct effect of propagating shock waves generated by the stellar pulsation, because SiO and H2O masers are sequentially distributed at different positions with respect to the central star. In addition, we analyzed long-term trends and characteristics of maser velocities, maser ratio, and the velocity extents (the full width at zero power; FWZP). We also investigated a spectral energy distribution (SED) ranging from 1.2 to 240 μm obtained using several infrared data: 2MASS, WISE, IRAS, ISO, COBE DIBRE, RAFGL, and AKARI (IRC and FIS). From the IRAS LRS and ISO SWS spectra of this star, we identified 9.7 and 12 μm silicate emission features consistent with the SE6 spectrum model, corresponding to the typical AGB phase.

[구 SA-02] Twelve-year simultaneous monitoring of the SiO and H_2O masers toward AGB stars: RT Vir, RR Aql, IRC-10151

Seong Min Son[1], Jaeheon Kim[2], Jang Ho Lim[1], Kyung-Won Suh[1], Se-Hyung Cho[2,3] Dong-Hwan Yoon[2], and Haneul Yang[2,3]
[1]*Department of Astronomy and Space Sciences, Chungbuk National University*
[2]*Radio Astronomy Division, Korea Astronomy and Space Science Institute*
[3]*Astronomy Program, Department of Physics and Astronomy, Seoul National University*

We present the results of long-term simultaneous monitoring observations (~ 12 years) of H_2O (22 GHz) maser and several vibrationally excited lines of SiO J = 1-0, 2-1, 3-2 masers (43, 86, 129 GHz) carried out with the 21-m antennas of the Korean VLBI Network (KVN) toward a sample of three AGB stars (RT Vir, RR Aql, IRC-10151) that are believed to be semiregular variable star, Mira variable star, and OH/IR star, respectively, according to a sequential evolutionary phase of AGB star. A total 10 transitions were observed, of which we detected H2O, SiO v = 1 and 2, J = 1-0, SiO v = 1, J = 2-1 and J = 3-2 maser lines in all three target objects, depending on the observational epochs. In this study, we scrutinize the evolutionary traits of each target object based on the maser line profiles, flux/velocity variations, and phase lags with the optical light curves. The IRAS two color diagram and the infrared spectral energy distributions (SEDs) in the wavelength range from 1.2 to 240 μm of three observed sources were also analyzed.

[구 SA-03] M to mid-L type members of

nearby young moving groups from Gaia EDR3

Jinhee Lee[1], Inseok Song[2], Simon J. Murphy[3]
[1]Pusan National University, [2]The University of Georgia, [3]The University of New South Wales Canberra

In this study, we aim to identify low-mass members of nearby, young stellar moving groups (NYMGs) from Gaia EDR3. The spatio-kinematic membership probabilities of the NYMGs were calculated utilizing the Bayesian membership probability calculation tool developed in our previous study. The youth of these spatio-kinematic members were assessed using positions on color-magnitude diagrams. We identified ~2200 new low-mass NYMG candidate members, that can be confirmed by follow-up spectroscopic observations. We performed pilot spectroscopic observation with WiFeS at Siding Spring Observatory observing 79 candidates, and about 80 per cent of them were confirmed as members.

[구 SA-04] A kinematic study of young stars in Monoceros OB1 and R1 associations

Beomdu Lim[1], Yaël Nazé[2], Jongsuk Hong[3], Sungyong Yoon[1], Jinhee Lee[4], Narae Hwang[3], Byeong-Gon Park[3], Jeong-Eun Lee[1]
[1]Kyung Hee University, [2]Université de Liège, [3]Korea Astronomy and Space Science Institute, [4]Pusan National University

The Gaia mission opens a new window to study the kinematics and dynamics of young stellar systems in detail. The kinematic properties of young stars provide vital constraints on the formation process of their host systems. Here, we present a kinematic study of the two associations Monoceros OB1 (Mon OB1) and R1 (Mon R1). Member candidates are first selected from the published list of member candidates, a compilation of OB star catalogues, and the classification of young stellar objects with the AllWISE data. According to the conventional wisdom, we selected a total of 728 members with similar proper motions at almost the same distance. Mon OB1 and Mon R1 have high levels of substructures that are also kinematically distinct. We identify six stellar groups in these associations, of which five show a pattern of expansion. In addition, the signature of rotation is found in two stellar groups of Mon OB1. Star formation history is inferred from a color-magnitude diagram. As a result, star formation in Mon OB1 has been sustained for several million years, while Mon R1 formed at almost the same epoch as the recent star formation in Mon OB1. Some old members in the outskirt of Mon OB1 have outward motions, which rules out the previously proposed outside-in star formation scenario. Star-forming regions including Mon OB1 and Mon R1 are found along a large arc-like gas structure. Hence, the formation of these two associations may originate from the hierarchical star formation along filaments in a turbulent molecular cloud.

[구 SA-05] Metallicity-dependent mixing length in evolution models of red supergiant stars in IC 1613

Sang-Hyun Chun[1,2], Sung-Chul Yoon[1,3], Heeyoung Oh[2]
[1]Department of Physics and Astronomy, Seoul National University, [2]Korea Astronomy and Space Science Institute, [3]SNU Astronomy Research Center, Seoul National University

There is increasing evidence that the convective mixing length (α) in stellar evolution models depends on metallicity of stars. In order to confirm a more precise metallicity-dependent mixing length trend, we investigate the effective temperature and metallicity of 14 red supergiant stars (RSGs) in the irregular dwarf galaxy IC 1613 using the near-infrared spectra observed with the MMIRS on the MMT telescope. From the synthetic spectral fitting to the observed spectra, we find that the mean metallicity is about [Fe/H]=0.69 with a weak bimodal distribution. We also find that the effective temperature of RSGs in IC 1613 is higher by about 250 K than that of the SMC on average. We compare the RSG position with stellar evolutionary tracks on the HR diagram, finding that models with α = 2.2-2.4 H_p can best reproduce the effective temperatures of the RSGs in IC 1613. It is evident that the mixing length values for IC 1613 is lower than that of the Milky Way. This result supports our previous study on a metallicity-dependent mixing length: mixing length decreases with decreasing metallicity of host galaxies. However, this dependency becomes relatively weak for RSGs having a metallicity equal to or less than the SMC metallicity.

[구 SA-06] Observational Feature of Ejecta-Companion Interaction of A Type Ia SN 2021hpr Via The Very Early Light Curve

Gu Lim[1,2] (임구), Myungshin Im[1,2] (임명신), Gregory S. H Paek[1,2] (백승학), Sung-Chul Yoon[1,2] (윤성철), Changsu Choi[1,2,4] (최창수), Sophia Kim[1,2] (김소피아), Jinguk Seo[1,2] (서진국), Wonseok Kang[3] (강원석), Taewoo Kim[3] (김태우), Hyun-Il Sung[4] (성현일),

Yonggi Kim[5] (김용기), Joh-Na Yoon[5] (윤요라), and IMSNG team
[1]*SNU Astronomy Research Center, Seoul National University, Seoul, Republic of Korea*
[2]*Astronomy Program, Department of Physics & Astronomy, Seoul National University, Seoul, Republic of Korea*
[3]*National Youth Space Center, Goheung, Jeollanam-do, Republic of Korea*
[4]*Korea Astronomy and Space Science Institute, Daejeon, Republic of Korea*
[5]*Chungbuk National University Observatory, Chungbuk National University, Cheongju, Republic of Korea*

The progenitor of Type Ia supernovae is largely expected as a close binary system of a carbon/oxygen white dwarf (WD) primary and its secondary non-degenerate (single degenerate; SD) or degenerate companion (double degenerate; DD). Here we present a high-cadence monitoring observation of SN 2021hpr in a spiral galaxy, NGC 3147. SN 2021hpr shows typical characteristics as a normal type Ia supernova from its photometric (Δm_{15}(B)=1.01±0.03, dust free $M_{B,max}$=-19.45±0.02) and spectroscopic data. To investigate its progenitor system, we fit the early part of *BVRI*-band light curve simultaneously with a combined version of ejecta-companion and simple power-law model. As a result, we found a significant feature of an early excess possibly from a 7.63±0.52$R_{\odot}$-sized companion at the optimal viewing angle while the fit is not successful at the common viewing angle. No possible red sources brighter than F555W=-7.01 AB mag is detected at the SN location in Hubble Space Telescope (HST) pre-explosion images, excluding massive stars with initial mass of >16$M_{\odot}$ as companions. We suggest the progenitor system of SN 2021hpr can be a fairly large companion such as a main sequence, a low mass subgiant, and a helium giant star. In addition, a possibility of the ejecta-Disk Originated Matter (DOM) interaction for the DD scenario considering linearly-rising early flux still remains.

고에너지/이론천문학

[구 HA-01] Preexsiting Suprathermal Electrons and Preacceleration at Quasi-Perpendicular Shocks in Merging Galaxy Clusters

Ji-Hoon Ha[1], Dongsu Ryu[1], Hyesung Kang[2] and Sunjung Kim[1]
[1]*Department of Physics, School of Natural Sciences UNIST, Ulsan 44919, Korea*
[2]*Department of Earth Sciences, Pusan National University, Busan 46241, Korea*

Merger shocks with $M_s < \sim 3-4$ have been detected in galaxy clusters through radio observations of synchrotron radiations emitted from cosmic-ray (CR) electrons. The CR electrons are believed to be produced by the so-called diffusive shock acceleration (DSA) at the merger shocks. To describe the acceleration of electrons, the injection into DSA has to be understood. Recent studies have showed that electrons could be energized through stochastic shock drift acceleration (SSDA), a mechanism mediated by multi-scale plasma waves at shock transition zone. However, such preacceleration process seems to be effective only at the supercritical shocks with $M_s > \sim 2.3$, implying that further studies should be done to explain radio relics with weaker shocks. In this talk, we present the results obtained by fully kinetic 2D particle-in-cell (PIC) simulations, which include pre-existing suprathermal electrons possibly ejected from active galactic nuclei (AGNs) or produced by previous episodes of turbulence/shocks. The simulations indicate that the pre-existing electrons enhance the upstream plasma waves in shocks with $M_s < \sim 2.3$. However, the wavelength of such waves is not long enough to scatter off suprathermal electrons and energize them to the injection momentum for DSA. Hence, we conclude that preexciting suprathermal electrons alone would not solve the problem of electron acceleration at radio relic shocks.

[구 HA-02] Features in broadband SEDs of young pulsar wind nebulae: existence of two different electron populations

Chanho Kim, Hongjun An
Department of Astronomy and Space Science, Chungbuk National University, Cheongju-si 28644, Republic of Korea

Pulsar Wind Nebula(PWN)는 radio부터 TeV band 까지 넓은 파장에 걸쳐 복사를 하며 이 복사는 Spectral Energy Distribution(SED)으로 측정된다. 관측된 SED는 두 개의 주요한 bump를 보이는데 low-energy emission bump는 synchrotron radiation에 의해 만들어지고 high-energy emission bump는 inverse Compton scattering에 의해 만들어진다. 대부분 PWN들의 SED는 단일 전자 분포로 설명이 가능하지만 최근 연구 결과에 의하면 Crab nebula, G21.5-0.9 같은 일부 young pulsar wind nebula의 X-ray SED에서 단차나 기울기의 변화 등 단일 전자 분포로 설명하기 어려운 부분이 관측되기도

한다. 이런 PWN에 대하여 우리는 이중 전자 분포를 이용해서 broadband SED가 잘 설명이 되는지 확인하고 이를 통하여 PWN 입자 가속의 특성을 이해해보고자 한다.

[석 HA-03] Applying intrabinary shock model to various X-ray observation data

Minju Sim and Hongjun An
Department of Astronomy and Space Sciences, Chungbuk National University, Republic of Korea

Low mass X-ray binary(LMXB) 중 accretion disk가 존재하지 않으며 매우 작은 질량 ($1 \ll M_{\odot}$)의 동반성을 가지는 pulsar binary system에서 중성자별과 동반성의 항성풍은 상호작용하여 intrabinary shock(IBS)을 형성한다. 이곳에서 입자들은 상대론적으로 가속되어 싱크로트론 복사를 방출한다고 생각된다. 이 복사는 X-선 영역으로 관측되며 이때 관측된 X-선 궤도 광도곡선은 IBS의 모양에 따라 달라진다. 우리는 IBS의 X-선 복사 과정을 모델화하여 shock의 모양과 내부의 전자 특성을 파악하고, 광학 관측을 통해 얻은 orbital parameter와 비교하며 binary의 geometry를 보다 정확히 이해하고자 한다. 이 발표에서는 다양한 pulsar binary system의 Chandra, XMM 그리고 NuSTAR의 X-선 관측 데이터에 IBS 모델을 적용해보고 IBS와 binary의 geomerty를 분석한 결과를 제시한다.

[구 HA-04] A correlation analysis about properties of quiescence magnetar

Jiwoo Seo, Jaewon Lee, and Hongjun An
Department of Astronomy and Space Science, Chungbuk National University, Cheongju, 28644, Republic of Korea

우리는 quiescent state magnetar의 물리적 특성을 연구하기 위해 복사특성이 잘 알려진 24개의 대상을 선정하였고 가장 어두운 시기(quiescent state)의 Chandra와 XMM-Newton의 X-ray 관측 데이터를 분석하여 복사특성과 시간 특성을 측정하였다. 이 측정을 이용하여 복사특성과 시간 특성 사이의 여러 경우에 대해 상관관계를 분석하였다. 그 결과 기존에 높은 상관관계를 갖는 것으로 알려진 표면 자기장(B_s)과 흑체복사 광도(L_{BB}), B_s 와 X-ray photon index (Γ_X) 관계를 더 많은 magnetar에 대하여 재확인하였으며, spin-down rate ($\dot{P}$) 와 L_{BB}, characteristic age (τ_c)와 L_{BB} 의 새로운 유의미한 관계를 찾았다. 또한 magnetar의 pulsed fraction (PF)과 흑체복사 반경(R_{BB}), PF 와 Γ_X, 그리고 $\dot{P}$ 과 Γ_X 가 서로 상관되어 있다는 단서를 확인하였다.

[석 HA-05] An Investigation of X-ray pulsation searches: Weighted vs unweighted H test

Jaewon Lee
Department of Astronomy and Space Science, Chungbuk National University

Timing analysis에서 pulsar 또는 magnetar의 pulsation 측정은 background 또는 주변의 다른 source의 영향으로 매우 세밀하게 측정을 진행해야 할 수 있다. 하지만 gamma-ray 영역에서는 instrument의 낮은 imaging resolution으로 인해 likeihood 분석법을 사용하며, pulsation측정의 sensitivity를 향상시키기 위해 weighted H-test를 적용하고 있다. weighted H-test는 Instrument의 responses와 source, background의 radiational properties를 이용하여 각 photon의 probability를 계산하고 이를 weight하여 pulsation detection의 sensitivity를 향상시키는 방법으로 이번 연구를 통해 이를 X-ray에서 적용할 수 있도록 확장하였다. 이번 발표에서는 X-ray 데이터 중 상대적으로 낮은 imaging resolution을 갖는 XMM-Newton data에 weighted H-test를 적용하여 기존의 H-test와의 차이를 비교해보고, weighted H-test가 갖는 이점에 대하여 논의하고자 한다.

천문우주관측기술

[구 AI-01] 7-Dimensional Telescope (7DT) for multi-messenger astronomy

Myungshin Im[1], Hyung Mok Lee[1], Jae-Hun Jung[2], Chunglee Kim[3], Arman Shafieloo[4], Z. Lucas Uhm[4], and the GW Universe team
[1]Seoul National University, [2]Pohang University of Science and Technology, [3]Ewha Womans University, [4]Korea Astronomy Space Science Institute

The 7-dimensional Telescope (7DT) is an innovative multiple telescope system that can perform a rapid identification of optical counterparts of gravitational-wave (GW) sources and a wide variety of other astronomical projects. This telescope is being developed as a part of the recently approved National Challenge program, the GW Universe project, with a full operation planned at the end of 2023. The word 7-dimension stands for x, y, z positions, the radial velocity, the time, the wavelength, and the flux of astronomical sources, implying the telescope's capability of performing time-series wide-field, IFU-type spectroscopic observations. The 7DT is composed of about twenty 0.5-m wide-field telescopes, and it can obtain spectral-imaging data at 40 different wavelengths to the depth of 20 AB mag with 3 min exposure for a given epoch. In this talk, we will introduce the telescope system, and outline its scientific capabilities with an emphasis on multi-messenger astronomy and a few other key science topics.

[구 AI-02] Status of KASI's Contribution to SPHEREx

Woong-Seob Jeong[1,2], Yujin Yang[1,2], Sung-Joon Park[1], Jeonghyun Pyo[1], Youngsoo Jo[1], Il-Joong Kim[1], Seungcheol Bang[1], Bomee Lee[1], SPHEREx Korean Consorthium
[1]Korea Astronomy and Space Science Institute, Korea, [2]University of Science and Technology, Korea

The KASI team are participating in the NASA MIDEX mission (PI Institute: Caltech), the all-sky infrared spectro-photometric surveyor SPHEREx (Spectro-Photometer for the History of the Universe, Epoch of Reionization, and Ices Explorer). The SPHEREx will provide us the first all-sky infrared spectro-photometric data set to probe the origin of our Universe, to explore the origin and evolution of galaxies, and to explore whether planets around other stars could harbor life. After the project PDR (Preliminary Design Review) was successfully passed on the last September, the fabrication of flight hardware is in progress. As an international partner, KASI deeply involved in all fields of projects, i.e., the development of calibration facility, the construction of data reduction modules and the science studies for the SPHEREx. After finishing the fabrication and test of calibration facility for the SPHEREx in this year, it will be delivered to Caltech. Here, we report the status of the SPHEREx project and the progress in the Korean participation.

[구 AI-03] Optical Clock Comparison using High-frequency VLBI Observations (고주파수 VLBI 관측을 이용한 광시계 비교)

Taehyun Jung[1,2], Myuoung-Sun Heo[3], Buseung Cho[4], Sang-Oh Yi[5], Jungwon Kim[6], Do-Heung Je[1], Do-Young Byun[1,2], Shuangjing Xu[1]
[1]Astronomy and Space Science Institute, [2]University of Science and Technology, [3]Korea Research Institute of Standard and Science, [4]Korea Institute of Science and Technology Information, [5]National Geographic Information Institute, [6]Korea Advanced Institute of Science and Technology

2030년경에는 현재 '초(second)'를 정의하는 세슘 원자의 마이크로파 주파수를 이용한 원자시계 보다 훨씬 더 정밀한 광주파수시계(이하 광시계)를 이용한 초의 재정의를 앞두고 있다. 전 세계 각국에서 개발된 광주파수 시계의 동등성 확보를 위해서는 10^{-17} 이상의 정밀도로 시각/주파수를 대륙 간에 비교할 수 있는 기술 개발이 필수적이다. 현재의 대륙 간 시각 비교에 사용되는 위성을 이용한 시각/주파수 비교 방식은 10^{-16} 수준의 정밀도가 한계이나, 한국천문연구원과 국토지리정보원이 보유한 전파망원경을 이용하여, 10^{-17} 수준 또는 이보다 나은 광시계 비교가 가능할 것으로 기대되고 있다. 본 연구에서는 천문연과 세종의 전파망원경을 이용하여 세계 최초로 22 GHz 대역에서 광섬유로 전송된 원자시계 신호를 이용한 VLBI 관측에 성공하였다. 이를 통해 고정밀 원자시계 비교 능력을 검증함으로써, 향후 초의 재정의에 가장 큰 당면 과제인 대륙간 고정밀 광시계 비교 연구의 실질적인 기반을 마련하였다. 이후 한-이태리 VLBI 관측을 통하여 표준과학연구원과 이탈리아 INRIM에서 개발한 두 광시계의 동등성 비교를 진행할 계획이다.

[구 AI-04] Python Package Prototype for Adaptive Optics Modeling and Simulation

Seonghwan Choi[1], Byungchae Bang[2], Jihun Kim[1], Gwanghee Jung[2], Ji-Hye Baek[1], Jongyeob Park[1], Jungyul Han[1], and Yunjong Kim[1]
[1]Korea Astronomy and Space Science Institute, [2]AntBridge, Inc.

Adaptive Optics (AO) was first studied in the field of astronomy, and its applications have been extended to the field of laser, microscopy, bio, medical, and free space laser communication. AO modelling and simulation are required throughout the system development process. It is necessary not only for proper design but also for performance verification after the final system is built. In KASI, we are trying to develop the AO Python Package for AO modelling and simulation. It includes modelling classes of atmosphere, telescope, Shack-Hartmann wavefront sensor, deformable mirror, which are the components for an AO system. It also includes the ability to simulate the entire AO system over time. It is being developed in the Super Eye Bridge project to develop a segmented mirror, an adaptive optics, and an emersion grating spectrograph, which are future telescope technologies. And it is planned to be used as a performance analysis system for several telescope projects in Korea.

[구 AI-05] IMSNG: Automatic Data Reduction Pipeline gppy for heterogeneous telescopes

Gregory S.H. Paek[1,2], Myungshin Im[1,2], Seo-won Chang[1,2], Changsu Choi[1,2], Gu Lim[1], Sophia Kim[1,2], Mankeun Jung[1,2], Sungyong Hwang[1,2], JoonhoKim[1,2], Hyun-il Sung[3], and IMSNG team[1,2]
[1]Astronomy Program, Department of Physics & Astronomy, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea
[2]SNU Astronomical Research Center, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea
[3]Korea Astronomy and Space Science Institute, 776 Daedeokdae-ro, Yuseong-gu, Daejeon 34005,

Korea

Although the era of very large telescopes has come, small telescopes still have advantages for fast follow-up and long-term monitoring observation. Intensive monitoring survey of nearby galaxies (IMSNG) aims to understand the nature of the supernovae (SNe) by catching the early light curve from them with the network of small telescopes from 0.4-m to 1.0-m all around the world. To achieve the scientific goals with heterogeneous facilities, three factors are important. First, automatic processes as soon as data is uploaded will increase efficiency and shorten the time. Second, searching for transients is necessary to deal with newly emerged transients for fast follow-up observation. Finally, the Integrated process for different telescopes gives a homogeneous output, which will eventually make connections with the database easy. Here, we introduce the integrated pipeline, 'gppy' based on Python, for more than 10 facilities having various configurations and its performance. Processes consist of image pre-process, photometry, image align, image combine, photometry, and transient search. In the connected database, homogeneous output is summarized and analyzed additionally to filter transient candidates with light curves. This talk will suggest the future work to improve the performance and usability on the other projects, gravitational wave electromagnetic wave counterpart in Korea Observatory (GECKO), and small telescope network of Korea (SOMANGNET).

교육홍보

[석 EP-01] A study on the effectiveness of STEAM education program applying 3D-modeling at astronomy Units

Sang-Geol Kim(김상걸), Hyoungbum Kim(김형범), Yonggi Kim(김용기), Hongsoon Choi(최홍순)
Chungbuk National University

천문학은 시간적·공간적 규모가 크기 때문에 학습자의 수준에 따라 공감과 이해의 정도에 차이가 크다. 2015 개정 과학과 교육과정에 따르면 초등학교 5학년부터 태양계에 대한 내용을 다루고 있다. 하지만 이를 설명하기 위한 교과서의 사진과 동영상 자료는 태양계를 명확하게 전달하기 어렵다. 이에 대한 대안으로 3D Modeling을 통한 체험 교육을 제안한다. 천문학 교과에서 3D Modeling의 적용은 학생들의 흥미, 태도의 향상 등 교육적 효과의 상승으로 이어진다. 이에 본 연구에서는 3D Modeling의 도구 중 3D 프린터와 레이저 절단기를 이용해 융합교육(STEAM) 프로그램을 개발하고 학생들에게 적용하여 창의적 문제해결능력에 미치는 영향을 알아보고자 한다. 초등학교 교육과정에 제시된 태양계 관련 학습자료를 분석하였고, 융합교육(STEAM)에서 제안하는 상황제시, 창의적 설계, 감성적 체험의 교육단계 중 '창의적 설계' 단계에 3D 프린터와 레이저 절단기를 통해 개발한 kit를 이용하여 융합교육(STEAM) 프로그램에 적용하였다. 개발된 프로그램을 형식 교육의 장에 적용하여 개발된 평가지표를 토대로 사전·사후 평가를 실시한다. 향후 3D Modeling을 초등학교 교육과정뿐만 아니라 중·고등학교 교육과정 또한 분석하여 적용한다면, 천문대중화를 위해 큰 도움이 될 수 있을 것으로 사료된다.

[석 EP-02] STEAM Training Program for Constellation Space Composition Using Laser Cutter and LED Light Source

Min Heo(허민), Geoyung Han Yoo(유경한), Yonggi Kim(김용기), HyoungBum KIM(김형범)
CBNU

지구과학 분야에서 가장 어렵게 느껴지는 내용인 천문분야는 다른 과학 분야와 달리 탐구 대상이 천체들이 먼 거리에 있고, 쉽게 관측하기 어려우며, 실험실에서 동일실험과 반복 실험이 불가능하여, 추상적이고 직접 관측하기 어려운 개념에 관한 연구들이 많다. 따라서 이 연구에서는 레이저 커팅기를 사용해 지구과학교과 중 별자리를 구성하는 별들의 상대적 거리를 수학적으로 계산하는 과정과 고등학교 물리교과 중 LED 광원의 원리를 알고 LED 모듈을 제작하여 최종적으로 아름답고 과학적으로 가치가 있는 입체 별자리 교구를 제작하는 형태의 STEAM 교육 프로그램을 개발하고 시범학교 적용을 하였다. 이에 지능정보화 사회에 발맞춰 천문학 지식을 창의 교육의 형태로 교육하는 새로운 교육법을 실현한 연구결과들을 발표하고 ㅓ자 한다. 또한 개발한 프로그램의 효과성을 검증하기 위해 STEAM 관련 태도 검사와 논리적 사고력 검사 및 만족도 검사를 실시하였다. 연구결과 개발된 프로그램이 STEAM 태도 검사와 논리적 사고력에 효과가 있는 것으로 나타났으며, 천문수업에 대한 학생들의 인식은 긍정적이었다. 따라서 후속 연구에서는 다양한 학년 및 위계에 맞는 프로그램의 개발과 다양한 지역 등의 현장 적용을 통한 연구가 진행되어야 할 것으로 판단된다.

[구 EP-03] Development and Introduction of Virtual Reality Astronomy Education Program Development (가상현실 천문학 교육프로그램 개발 및 소개)

Sanghyun Ha[1,2], Jungjoo Sohn[1], Soonchang Park[2]
[1]*Korea National Univertiry of Education,*
[2]*METASPACE*

지난 연구에서는 국립과학관 천체투영관 등에서 사용하는 천체시뮬레이션 소프트웨어를 활용하여 스크립트 제작 및 360° VR 영상 제작기술을 개발하였고, 비대면 환경에서도 개인휴대기기 등을 통한 몰입도 높은 천문학 교육을 구현할 수 있도록 연구를 진행하였다.

계속되는 연구로 천체시뮬레이션을 활용한 교육프로그

램의 장점을 잘 나타낼 수 있는 주제들 중 2015 교육과정 중학교 3학년에서 다루는 '우주 탐사 성과와 의의'를 주제로 파일럿 프로그램을 개발 중이며 그 과정을 소개하고자 한다. 개발하는 프로그램은 과학관 천체투영관에 적용하여 실무자의 활용을 지원할 계획이며 다양한 교육콘텐츠 개발에 활용되기를 기대한다.

[구 EP-04] Development of the astronomical education kits using 3D printer and its application

Jongjin Lim(임종진), Yonggi Kim(김용기), Hyoungbum Kim(김형범), Taeyong Ha(하태용)
Chungbuk National University

천문 분야는 다른 과학 분야와 달리 탐구대상인 천체들이 먼 거리에 있고, 실험실에서 동일 실험과 반복 실험이 불가능하며, 추상적이고 직접 관측하기 어려운 개념에 대한 연구들이 많다. 따라서 최근 인공지능, 증강현실 및 3D 프린팅 기술 등은 천문교과 교육과정과 연계하여 학생들의 지각 능력을 자극하고 실제 활동과 유사한 경험을 제공할 수 있도록 단계적인 학습경험을 도와 천문 분야 체험활동으로 연결시키고 있다. 이에 본 연구는 학생들이 망원경의 원리와 분해 및 조립에 대한 지식함양을 위해 3D 프린팅 기술과 AR을 활용하여 학생들의 천문관측 망원경에 대한 이해와 천문관련 체험활동에 대한 프로그램을 개발하여 적용하였다.

이 연구에서 개발한 프로그램은 3D 프린팅 기술을 활용하여 망원경의 세부 부품을 학생들이 직접 설계 및 제작하고, 자석을 이용하여 망원경을 조립, 분해 실습을 할 수 있도록 하였다. 또한, AR(증강현실)을 활용하여 빛을 모으는 망원경의 구조를 직접 실험을 통해 확인하고 빛의 반사와 굴절 원리를 학습하는 내용을 개발 프로그램에 포함하였다.

[구 EP-05] Development and Fabrication of Astronomical Exhibitions

Chang Hyun Baek, Cheolhee Kim
National Science Museum

2020년 한국천문연구원 보현산천문대의 태양망원경이 국립중앙과학관으로 이전·설치되었다. 태양망원경 이전과 함께 신규로 건립된 국립중앙과학관의 천체관측소 운영을 활성화 하고 전시 및 교육 기능을 강화하기 위한 천문학 전시 콘텐츠를 개발하고 전시품을 제작하였다. 본 발표에서는 태양망원경 이전과정, 개발 중인 전시 콘텐츠와 제작된 전시품 등을 소개하고 앞으로 전국 지역 천문교육시설에서도 활용할 수 있는 천문학 전시 콘텐츠와 소규모 전시품 등을 제안해 보고자 한다.

[구 EP-06] Hybrid Astronomy and Space Science Room (하이브리드방식의 천문우주과학교실)

Taewoo Kim, Sun-gill Kwon, Sungjin Ahn, Wonseok Kang, Miso Park, Sohee Kim
National Youth Space Center

국립청소년우주센터는 전라남도 과학문화확산활동사업으로 하이브리드방식의 천문우주과학교실을 운영하고 있다. 사업은 '소통하는 천체관측 플랫폼'과 '내가 만든 천체사진' 프로그램 두 가지로 운영 중이다. '소통하는 천체관측 플랫폼'은 날씨가 맑은 날 시민이 있는 곳을 찾아가서 천체를 보여주며 인터뷰와 생중계를 하는 것이다. '내가 만든 천체사진 프로그램'은 하이브리드 방식으로 프로그램을 운영하며 기존에 촬영된 천체사진과 원격관측을 이용해서 날씨에 상관없이 천체사진을 제작 할 수 있게 운영된다. 밤하늘의 천체를 안시관측으로만 만족하지 않고 사진관측의 매력을 알려 천문관측의 패러다임을 변화 시킬 수 있도록 운영한다. 또한 천문관측을 값비싼 장비가 있는 곳에서만 가능 한 것이 아니고 장비공유를 통해 천문관측을 할 수 있도록 시스템을 구축했다.

[특별세션] LSB Universe with K-DRIFT

[구 KDC-01] A Brief Overview of the KASI-Deep Rolling Imaging Fast-optics Telescope(K-DRIFT): Exploring the Low-surface-brightness(LSB) Universe

K-DRIFT Collaboration: Jongwan Ko[1,2] et al.
[1]*Korea Astronomy and Space Science Institute,*
[2]*University of Science and Technology*

한국천문연구원에서는 낮은 표면밝기(Low Surface Brightness; LSB)의 천체를 효율적으로 관측할 수 있는 소형(〉30cm) 광시야(〉1°×1°) 광학망원경 및 관측기술 개발을 통한 은하형성 규명 연구를 수행 중에 있다. 이번에 개발한 K-DRIFT pathfinder는 비축 자유곡면 3반사 망원경 시스템(Linear Astigmatism Free-Three Mirror System; LAF-TMS)으로 넓은 시야에서 고품질의 이미지를 효율적으로 얻을 수 있는 광학 설계를 적용하고, 배경값 변동 요인을 분석하여 가까운 우주의 LSB 천체 관측에 최적화될 수 있도록 하였다. 이번 특별세션에서는 '왜 LSB 우주 탐사를 하고, K-DRIFT를 개발하는지?'에 대해서 소개하고, K-DRIFT pathfinder의 개발 과정, 보현산천문대에서의 시험관측 결과 소개와 함께, LSB 천체 연구를 위한 맞춤형 시뮬레이션 개발 및 수행 내용을 소개한다.

[구 KDC-02] The Design of the Linear-Astigmatism-Free Three-Mirror System for K-DRIFT (선형비점수차가 제거된 비축 3반경 K-DRIFT 망원경의 설계)

K-Drift Collaboration: Seunghyuk Chang et al
Center for integrated smart sensors

The optical design of the Linear-Astigmatism-Free Three-Mirror-System (LAF-TMS) for KASI-Deep

Rolling Imaging Fast-optics Telescope(K-DRIFT) is presented. LAF-TMS is an all-reflective imaging system consists of three freeform mirrors. Due to its well-corrected aberrations and obstruction-free clear aperture, the LAF-TMS provides a wide field of view with very low scattered lights.

[구 KDC-03] Fabrication, Assembly and Alignment of the Off-axis Freeform K-DRIFT Pathfinder

K-DRIFT Collaboration: Yunjong Kim[1] ,Dohoon Kim[2] et al.
[1]*Korea Astronomy and Space Science Inititute,*
[2]*Green Optics Co., Ltd.*

표준우주모형이 예측하는 천체의 성장 역사를 추적하기 위해서는 보통의 밤하늘 밝기보다 약 1000배 어두운 낮은 표면밝기(Low Surface Brightness, LSB) 우주 탐사가 필요하지만, 관측기술의 한계로 아직 LSB 우주는 거의 미지의 세계에 있다고 할 수 있다. 한국천문연구원에서는 LSB 천체 관측에 최적화된 직경 300 mm K-DRIFT Pathfinder 망원경을 개발하였다. LSB 천체는 ~28 mag/arcsec2 보다 어두운 천체로 표면밝기가 매우 낮기 때문에 망원경 내부의 미광(stray light)을 최소화하는 것이 중요하다. 이를 구현하기 위해 K-DRIFT Pathfinder 망원경에는 선형 비점수차가 제거된 비축 자유곡면 삼 반사경 형태를 적용하였다. 본 연구를 통해 가시광 영역에서 선형 비점수차가 제거된 비축 자유곡면 삼 반사 망원경의 설계, 제작 및 측정 가능성을 검증하였다. 본 발표에서는 K-DRIFT Pathfinder 망원경에 적용된 비축 자유곡면 광학면의 가공, 삼 반사 망원경의 조립 및 정렬 결과를 소개한다.

[구 KDC-04] A Simulation Study for Mid-spatial Frequency Errors: Scattering Effects from Residual Optical Fabrication Errors

K-DRIFT Collaboration: Gayoung Lee[1] Yunjong Kim[2], Kwang-Il Seon[2,3] et al.
[1]*Kyungpook National University*
[2]*Korea Astronomy and Space Science Institute,*
[3]*University of Science and Technology*

한국천문연구원에서는 LSB 천체 관측에 최적화된 유효직경 300 mm의 비축 자유곡면 K-DRIFT pathfinder 망원경을 개발하였다. 밝은 별로 시험관측을 한 결과 설계에서 예상된 점퍼짐함수(point spread function)보다 약 5배 정도 (또는 목표로 한 점퍼짐함수보다 약 1.5배 정도) 큰 점퍼짐함수를 얻었다. 이에 대한 원인 분석 결과 비축 자유곡면을 가공하면서 발생한 툴 마크에 의한 MSF (Mid-Spatial Frequency) 효과가 점퍼짐함수 증가에 주도적인 영향을 주는 것으로 판단되었다. 본 발표에서는 반사경면의 MSF를 다양한 조건에 따라 시뮬레이션한 결과를 소개하고 이를 토대로 실제 반사경 제작에서 MSF 효과를 최소화 하는 방안에 대해 논의하고자 한다.

[구 KDC-05] First Results from the K-DRIFT pathfinder: A Single Curved Stellar Stream in the Nearby Galaxy NGC 5907

K-DRIFT collaboration: Woowon Byun[1,2] et al.
[1]*Korea Astronomy and Space Science Institute*
[2]*University of Science and Technology, Korea*

In a ΛCDM universe, most galaxies are believed to evolve by mergers and accretions. The debris resulting from such processes remains faint and/or diffuse structures, such as tidal streams and stellar halos. Although these structures are a good indicator of the recent mass assembly history of galaxies, they have the disadvantage of being difficult to observe due to their low surface brightness (LSB). To recover these LSB features by reducing the photometric uncertainties introduced by the optics system, we attempt to develop an optimized telescope, called a linear astigmatism free-three mirror system, that minimizes the loss and scattering of light within the telescope. With that prototype, we observe NGC 5907, known as a nearby galaxy with a fabulous loop structure(s), to inspect its performance. After a dedicated data reduction process, including flat-fielding with dark sky flat and sky subtraction, our observation reaches a 1σ surface brightness limit of $\mu_{lim,r} \simeq 28.3$ mag arcsec-2 in 10×10 arcsec boxes. We finally identify a single tidal stream that is likely the remnant of a nearly disrupted galaxy. This finding emphasizes that the capability of LSB detection with our telescope is comparable to that of much larger telescopes.

[구 KDC-06] Studies of LSB Features with K-DRIFT: Galactic Cirrus Clouds and Extragalactic Objects

K-DRIFT Collaboration: Kwang-Il Seon[1,2] et al.
[1]*Korea Astronomy and Space Science Institute,*
[2]*University of Science and Technology*

The low surface brightness (LSB) universe has been largely unexplored. The LSB structures are extremely difficult to image due to systematic errors of sky subtraction and scattered light in he atmosphere and in the telescope. Among the systematic errors of sky subtraction, the widespread presence of Galactic cirrus clouds is one of the major obstacles in studying the LSB features of extragalactic sources. Interstellar dust clouds are also fundamental to understand many issues in the Milky Way. Therefore, understanding the Galactic cirri is a crucial topic in the LSB studies. We present the ubiquitousness and current

understanding of the Galactic cirri. We also discuss what is necessary to study the LSB features with K-DRIFT and what we can learn from the K-DRIFT observations.

[구 KDC-07] A novel simulation technique invented for studying low-surface brightness features in and around galaxies: Galaxy Replacement Technique (GRT)

Jihye Shin[1], Kyungwon Chun[1], Rory Smith[1,2], Jongwan Ko[1,2]
[1]Korea Astronomy and Space Science Institute (KASI)
[2]University of Science Technology (UST)

K-SIM (KASI-Simulation) research project is dedicated to develop new numerical techniques in order to theoretically study galaxy formation and evolution. As the first step of the K-SIM, to model tidal stripping of galaxies with a very high resolution in a fully cosmological context, we invented the Galaxy Replacement Technique (GRT) that is very efficient and fast. The high resolution allows us to accurately resolve the tidal stripping process and well describe the formation of ultra-low surface brightness features in the galaxy cluster (μV < 32 mag/arcsec^2), such as the intra-cluster light, shells and tidal streams. I'll introduce how the GRT is designed and which science topics in low-surface brightness regime can be visited using the GRT.

[특별세션] Rendezvous Mission to Apophis

[구 RMA-01] Rendezvous Mission to Apophis: I. Mission Overview

Young-Jun Choi[1,2] on behalf of the RMA Team
[1]Korea Astronomy and Space Science Institute,
[2]University of Science and Technology

An asteroid is important for understanding the condition of our solar system in early-stage because an asteroid, considered as a building block of the solar system, preserves the information when our solar system was formed. It has been continuously flowing into the near-Earth space, and then some asteroids have a probability of impacting Earth. Some asteroids have valuable minerals and volatiles for future resources in space activity.

Korean government clarified, in the 3rd promotion plan for space activity, an asteroid sample return mission by the mid-2030s. However, it is almost impossible to do so based on only a single experience of an exploration mission to the Moon, Korea Pathfinder Lunar Orbiter, which will be launched in mid-2022. We propose a Rendezvous Mission to Apophis(RMA), beneficial in terms of science, impact hazardous, resource, and technical readiness for the space exploration of Korea.

[구 RMA-02] Rendezvous Mission to Apophis: II. Science Goals

Myung-Jin Kim[1], Hong-Kyu Moon[1], Young-Jun Choi1[2], Minsup Jeong[1], Masateru Ishiguro[3], Youngmin JeongAhn[1], Hee-Jae Lee[1], Hongu Yang[1], Seul-Min Baek[1], Jin Choi[1], Chae Kyung Sim[1], Dukhang Lee[1], Dong-Heun Kim[1,4], Eunjin Cho[1,2], Mingyeong Lee[1,2], Yoonsoo Bach[3], Sunho Jin[3], Jooyeon Geem[3], Hangbin Jo[3], Sangho Choi[5], Yaeji Kim[6], Yoonyoung Kim[7], Yuna Kwon[7]
[1]Korea Astronomy and Space Science Institute, [2]Univ of Science and Technology, [3]Seoul National Univ, [4]Chungbuk National Univ, [5]Yonsei Univ, [6]Auburn Univ, USA, [7]Technical Univ of Braunschweig, Germany

99942 Apophis is an Sq-type Potentially Hazardous Asteroid (PHA) with an estimated diameter of 370 m. It will approach the Earth down to 31,000 km from the surface during the encounter on April 13, 2029 UT, which is closer than geostationary satellites. This once-in-a-20,000 year opportunity would further expand our knowledge on the physical and dynamical processes which are expected to occur due to the gravitational tidal forces when an asteroid encounter with a planet. It will also provide an opportunity to promote great knowledge of the science of planetary defense. The science goal of the Apophis mission is to global-map the asteroid before and after the Earth's approach. In this talk, we will present scientific objectives, and briefly introduce instruments and operation scenarios of the mission.

[구 RMA-03] Rendezvous Mission to Apophis: III. Polarimetry of S-type: For A Better Understanding of Surficial Evolution

Jooyeon Geem[1](김주연), Minsup Jeong[2](정민섭), Sunho Jin[1](진선호), Chae Kyung Sim[2](심채경), Yoonsoo P. Bach[1](박윤수), Masateru Ishiguro[1], Yuna G. Kwon[3](권유나), Hong-Kyu Moon[2](문홍규), Young-Jun Choi[2](최영준), Myung-Jin Kim[2](김명진)
[1]Seoul National University (서울대학교), [2]Korea Astronomy and Space Science Institute (한국천문연구원), [3]Technische Universität

Braunschweig

Asteroids have undergone various processes such as impacts, space weathering, and thermal evolution. Because they expose their surfaces to space without atmosphere, these evolutional processes have been recorded directly on their surfaces. The remote-sensing observations have been conducted to reveal these evolutional histories of the target asteroids. For example, crater and boulder distributions are unambiguous evidence for past nondestructive impacts with other celestial bodies. Multiband and spectroscopic observations have revealed space-weathering history (as well as compositions).

Whereas most physical quantities have been examined intensively using spacecraft and telescopes, only a little has been studied on "the grain size". It is one of the fundamental physical quantities for diagnosing the collisional and thermal history of asteroids. Our group has conducted polarimetric research of asteroids (as well as Moon [1]) to determine the particle size and further investigate the evolutional histories of target asteroids [2],[3]. For example, the existence of regolith on an S-type asteroid, Toutatis, was suggested almost twenty years before space exploration [4]. Moreover, we reported that near-Sun asteroids indicate a signature of submillimeter grains, which could be created by a thermal sintering process by solar radiation [5].

However, it is important to note that in-situ polarimetry has not been reported on the asteroid surface, although the Korean Lunar Exploration Program aims to do polarimetry on the lunar surface [6]. Therefore, it is expected that the polarizer mounted on the Korean Apophis spacecraft can make the first estimate of the grain size and its regional variation over the Apophis surface.

In this presentation, we outline research of S-type asteroid surfaces through remote-sensing observations and consider the role of polarimetry. Based on this review, we consider the purpose, potentiality, and strategy of the polarimetry using the onboard device for the Apophis spacecraft. We will report a possible polarization phase curve of Apophis estimated from ordinary chondrites and past observational data of S-type asteroids, taking account of the space weathering effect. Based on this estimation, we will consider the strategy of how to determine the particle size (and space weathering degree) of the Apophis surface. We will also mention the detectability of dust hovering on the surface.

[1] Jeong, M., Kim, S. S., et al. ApJS 221, 1, 16, 2015, [2] Ishiguro, M. et al. Astron. J. 154, 5, 180, 2017, [3] Geem, J. Ishiguro, M. et al. (A&A, under review), [4] Ishiguro, M. et al. PASJ 49, L31, 1997, [5] Ito, T., Ishiguro, M. et al. Nature Comm. 9, 2486, 2018, [6] Jeong, M., Choi, Y.-J., et al. LPICo 1986, 7035, 2017

[구 RMA-04] Rendezvous Mission to Apophis: IV. Investigation of the internal structure – A lesson from an analogical asteroid Itokawa

Sunho Jin[1], Yaeji Kim[2], Hangbin Jo[1], Hongu Yang[3], Yuna G. Kwon[4], Masateru Ishiguro[1], Minsup Jeong[3], Hong-Kyu Moon[3], Young-Jun Choi[3,5], and Myung-Jin Kim[3]

[1]Seoul National Univ., [2]Auburn Univ., USA, [3]Korea Astronomy and Space Science Institute, [4]Technical Univ. of Braunschweig, Germany [5]Univ. of Science and Technology

Exploration of asteroids' internal structure is essential for understanding their evolutional history. It also provides a fundamental information about the history of coalescence and collision of the solar system. Among several models of the internal structures, the rubble-pile model, confirmed by the near-Earth asteroid (25143) Itokawa by Hayabusa mission [1], is now widely regarded as the most common to asteroids with size ranging from 200 m to 10 km [2]. On the contrary, monolithic and core-mantle structures are also possible for small asteroids [3]. It is, however, still challenging to look through the interior of a target object using remote-sensing devices. In this presentation, we introduce our ongoing research conducted at Seoul National and propose an idea to infer the internal structure of Apophis using available instruments.

Itokawa's research provides an important benchmark for Apophis exploration because both asteroids have similar size and composition [4][5]. We have conducted research on Itokawa's evolution in terms of collision and space weathering. Space weathering is the surface alteration process caused by solar wind implantation and micrometeorite bombardment [6]. Meanwhile, resurfacing via a collision acts as a counter-process of space weathering by exposing fresh materials under the matured layer and lower the overall degree of space weathering. Therefore, the balance of these two processes determine the space weathering degrees of the asteroid. We focus on the impact evidence on the boulder surface and found that space weathering progresses in only 100-10,000 years and modifies the surface optical properties (Jin & Ishiguro, KAS 2020 Fall Meeting).

It is important to note that the timescale is significantly shorter than the Itokawa's age,

suggesting that the asteroid can be totally processed by space weathering. Accordingly, our result triggers a further discussion about why Itokawa indicates a moderately fresh spectrum (Sq-type denotes less matured than S-type). For example, Itokawa's smooth terrains show a weaker degree of space weathering than other S-type asteroids [7]. We conjecture that the global seismic shaking caused by collisions with >1 mm-sized interplanetary dust particles induces granular convection, which hinders the progression of space weathering [8]. Note that the efficiency of seismic wave propagation is strongly dependent on the internal structure of the asteroid.

Finally, we consider possible approaches to investigate Apophis's internal structure. The first idea is studying the space weathering age, as conducted for Itokawa. If Apophis indicates a younger age, the internal structure would have more voids [9]. In addition, the 2029 close encounter with Earth provides a rare natural opportunity to witness the contrast between before and after the event. If the asteroid exhibits a slight change in shape and space weathering degree, one can determine the physical structure of the internal materials (e.g., rubble-pile monolithic, thick or thin regolith layer, the cohesion of the materials). We will also consider a possible science using a seismometer.

References

[1] Fujiwara et al., 2006, Science, Volume 312, Issue 5778, p. 1330-1334.

[2] Walsh, 2018, Annual Review of Astronomy and Astrophysics, vol. 56, p.593-624.

[3] Asphaug et al., 2002, Asteroids III, W. F. Bottke Jr., A. Cellino, P. Paolicchi, and R. P. Binzel (eds), University of Arizona Press, Tucson, p.463-484

[4] Brozovic et al., 2018, Icarus, Volume 300, p. 115-128.

[5] Binzel et al. 2009, Icarus, Volume 200, Issue 2, p. 480-485.

[6] Pieters and Noble, 2016, Journal of Geophysical Research: Planets, Volume 121, Issue 10, p. 1865-1884.

[7] Ishiguro et al., 2007, Meteoritics & Planetary Science, vol. 42, Issue 10, p.1791-1800.

[8] Shestopalov et al., 2013, Icarus, Volume 225, Issue 1, p. 781-793.

[9] Richardson et al., 2020, Icarus, Volume 347, article id. 113811.

[구 RMA-05] Rendezvous Mission to Apophis: V. Wide-Angle Camera Science

Youngmin JeongAhn(정안영민)[1], Hee-Jae Lee(이희재)[1], Minsup Jeong(정민섭)[1], Myung-Jin Kim(김명진)[1], Jin Choi(최진)[1], Hong-Kyu Moon(문홍규)[1], Young-Jun Choi (최영준)[1,2]
[1]Korea Astronomy and Space Science Institute, [2]Univ of Science and Technology

The Korean spacecraft for the exploration of Apophis will be equipped with an optical navigation camera with a wide-angle lens. The major purpose of the wide-angle camera is to capture imagery during the rendezvous phase in order to determine the spacecraft's position and the pointing direction relative to the asteroid Apophis. Two potential sciences, however, can be achieved by the wide-angle camera: (1) to measure the high-order gravity terms, and (2) to capture possible ejecting small particles. In this presentation, we will discuss instrument specification and operation scenario required to accomplish the given science objectives.

[구 RMA-06] Rendezvous Mission to Apophis: VI. Observation Campaign during the 2021 Apparition

Hee-Jae Lee[1], Myung-Jin Kim[1], Dong-Heun Kim[1,2], Hong-Kyu Moon[1], and Young-Jun Choi[1,3] on behalf of the Apophis Observation Team
[1]Korea Astronomy and Space Science Institute, [2]Chungbuk National University, [3]University of Science and Technology

On March 6 2021, Apophis made a close approach to the Earth with a minimum distance of 0.11 AU when the apparent magnitude reached up to V~16. This was the most favorable condition to observe this asteroid until its 2029 encounter. The observations during this apparition were extremely important to determine major physical properties, such as size, rotational state, 3D shape model, surface mineral properties. So, we organized the observation campaign during the 2021 apparition. The main goals of our campaign are to refine the spin state and 3D shape model and check the surface composition variations. The campaign involved dozens of countries and included ground-based photometry and spectroscopy, and spacecraft observations. Our timely observation campaign will provide essential data in planning the operation scenario for the space mission. In this presentation, we will report the preliminary result of the Apophis observation campaign during the 2021 apparition.

[특별세션] Gravitational Wave Detection Technology

[구 GWDT-01] Ground based interferometric gravitational wave detector and its technologies

June Gyu Park (박준규), Chang-Hee Kim (김창희), Sungho Lee (이성호), Yunjong Kim (김윤종), Hyeon Cheol Seong (성현철), Ueejeong Jeong (정의정), Soonkyu Je (제순규),
Korea Astronomy and Space Science Institute (한국천문연구원),

현재 중력파 관측은 레이저 간섭계 기반의 중력파 검출기를 통해 이루어지고 있고 검출기 성능이 개선되고 안정화 되어 초기 설계 사양 이상의 관측감도를 확보하였다. 이제 레이저 간섭계 기반의 중력파 관측 기술은 중력파 관측 가능성의 유무를 넘어 차세대 중력파 검출기의 건설을 앞당기는 수준이 되었으며 해외에서는 중력파 검출 기술을 선도하기 위한 공격적인 투자가 이루어 지고 있다. 이 발표에서는 현재 운영중인 레이저 간섭계 기반의 중력파 검출기의 중력파 검출 원리와 실제 중력파 검출기에서 사용되는 관련 핵심 기술들을 소개하고자 한다. 단순히 특정 분야의 일부 기술이 아닌 중력파 검출기 건설에 사용된 재료, 광학, 기계공학, 전자, 통신 등 다양한 분야의 기술을 소개하고 실제 중력파 검출기 관련 연구에 참여할 수 있는 연구 주제를 소개하고자 한다.

[구 GWDT-02] Development and International Collaborations on Quantum Noise Reduction Technology for Gravitational Wave Detectors (중력파 검출기 양자잡음 저감기술 개발 및 국제협력)

Sungho Lee (이성호)[1], Chang-Hee Kim (김창희)[1], June Gyu Park (박준규)[1], Yunjong Kim (김윤종)[1], Hyeon Cheol Seong (성현철)[1], Ueejeong Jeong (정의정)[1], Soonkyu Je (제순규)[1], Young-Sik Ra (라영식)[2], Geunhee Gwak (곽근희)[2], Youngdo Yoon (윤영도)[2], Byeong Yoon Go (고병윤)[2], Hyunjin Kim (김현진)[2], Chan Roh (노찬)[2]
[1]Korea Astronomy and Space Science Institute (한국천문연구원), [2]Korea Advanced Institute of Science and Technology (한국과학기술원)

중력파 관측은 2015년에 사상 최초로 검출에 성공한 이래, 불과 5년 만에 주 1 회 이상 안정적으로 검출되고 있으며 검출기들의 성능이 계속 향상됨에 따라 관측 범위와 빈도가 급격히 확대되는 추세에 있다. 이제 중력파는 전자기파 외에 우주를 보는 새로운 창으로서 확고한 지위를 구축하고 있으며 향후 무궁무진한 발전의 잠재력을 보여주고 있다. 이러한 가능성을 일찌감치 내다본 미국과 유럽의 선도 국가들은 현재 운영 중인 LIGO와 Virgo 검출기의 지속적인 업그레이드는 물론 Cosmic Explorer, Einstein Telescope 등 차세대 거대 검출기 개발을 병행해서 진행하고 있으며, 일본, 인도, 중국, 호주 등 후발주자들도 제각기 다양한 중력파 검출기 계획들을 추진하고 있다. 이에 한국천문연구원에서도 2019년부터 중력파 검출기술 연구를 시작하였으며, 특히 한국과학기술원 물리학과와 협력하여 차세대 핵심기술인 양자잡음 저감기술을 중점적으로 개발하고 있다. 이 발표에서는 본 연구팀의 최근 연구 진행상황을 요약하고 국제 중력파 검출기 공동개발 참여 현황을 소개한다.

[구 GWDT-03] Development of 1064 nm squeezer for quantum non-demolition measurement in gravitational wave detector

June Gyu Park (박준규), Chang-Hee Kim (김창희), Sungho Lee (이성호), Yunjong Kim (김윤종), Hyeon Cheol Seong (성현철), Ueejeong Jeong (정의정), Soonkyu Je (제순규)
Korea Astronomy and Space Science Institute (한국천문연구원)

Squeezed vacuum injection을 이용한 중력파 검출기의 관측감도 향상 기술은 중력파 검출기 광신호의 양자 잡음을 제어하여 관측감도를 높이는 기술로 이론적으로는 10dB에 가까운 신호 대 잡음비 향상을 달성할 수 있다. 실험실 환경에서는 이미 10dB 이상의 신호 대 잡음비 향상을 달성했으며 실제 중력파 검출기에서는 GEO600의 6 dB의 신호 대 잡음비 향상이 현재까지 가장 높은 수준이다. 한국천문연구원에서는 2019년부터 차세대 중력파 검출기 기술개발로 1064 nm 파장의 squeezer 개발을 추진했으며 현재 parametric down conversion을 이용해 squeezed vacuum을 생성하는 공진기를 제작하여 시험하는 단계에 있다. 이 발표에서는 한국천문연구원의 1064 nm squeezer 개발 연구와 개발 현황에 대해 소개하고자 한다.

[구 GWDT-04] Squeezed light generation at 1550nm (1550nm 파장의 압축광 개발)

Geunhee Gwak (곽근희)[1], Youngdo Yoon (윤영도)[1], Byeong Yoon Go (고병윤)[1], Chang-Hee Kim (김창희)[1], Sungho Lee (이성호)[2], June Gyu Park (박준규)[2], Soonkyu Je (제순규)[2], Ueejeong Jeong (정의정)[2], Yunjong Kim (김윤종)[2], Hyeon Cheol Seong (성현철)[2], Young-Sik Ra (라영식)[1]
[1]Korea Advanced Institute of Science and Technology (한국과학기술원),
[2]Korea Astronomy and Space Science Institute (한국천문연구원)

차세대 중력파 검출기들이 1.5 μm 이상의 장파장에서의 양자광원을 필요로 함에 따라, 이에 대한 기술 개발의 중요성이 대두되고 있다. 차세대 검출기들은 기존의 검출기에 사용되는 test mass를 fused silica에서 silicon으로 변경하면서 열팽창 현상으로 인해 생기는 정밀도의 한계를 뛰어넘으려한다. 하지만 1064 nm 파장의 경우 silicon

에서 흡수율이 매우 높으므로 사용할 수 없기에, 흡수율이 상대적으로 낮은 1.5 μm 이상의 영역의 양자광원이 필요하다.

본 발표에서는 1550 nm 파장에서 압축광 개발에 필요한 기술들을 소개하고, 현재까지 진행된 실험 및 실험결과들을 보고하고자 한다. 압축광의 pump빔을 만드는 SHG, 압축광이 생성되는 OPO, 생성된 압축광의 quadrature를 측정하기 위한 호모다인 측정기, 빛의 분광 잡음을 줄이고, 원하는 spatial mode로 여과시켜주는 mode cleaning cavity에 대한 내용을 설명한다.

[구 GWDT-05] Mode-mismatch-robust squeezed light from a self-imaging optical parametric oscillator

Chan Roh (노찬), Geunhee Gwak (곽근희), and Young-Sik Ra (라영식)
Korea Advanced Institute of Science and Technology (한국과학기술원)

Squeezed light는 중력파 검출기의 양자 잡음을 줄여 측정의 민감도를 향상시키기 위해 사용하는 양자 광원이다. Squeezed light는 광학적 손실에 민감하기 때문에 중력파를 측정하기 위해서는 정밀한 mode matching이 필요하다. 하지만 mode mismatching은 실제 실험 상황에서 동적으로, 그리고 무작위로 나타나므로 정밀하게 조정하기 어렵다. Mode mismatching에 견고한 squeezed light를 만들기 위해서는 multimode squeezed light가 필요하다. Multimode squeezed light를 만드는 방법으로는 self-imaging cavity를 이용하여 생성하는 방법이 대표적으로 알려져 있다. 이 발표에서는 self-imaging cavity 기반으로 만든 optical parametric oscillator (OPO) 에서 생성된 squeezed light가 기존 OPO로 생성한 squeezed light 보다 여러 spatial mode mismatching (위치, 방향, 크기 빗맞음)에 대해 견고함을 소개한다.

[특별세션] Life in Cosmos Exploration

[구 LiCE-01] Research issues on biosignature and life in the Solar System and exoplanets

Min-Su Shin (M.-S. Shin), Sun-Ju Chung (S.-J. Chung), and LiCE team
KASI

We present the current focus issues on biosignature and life in the Solar System and exoplanters considering the possible research items at KASI in collaboration with other fields and institutes. We also suggest possible KASI research projects that can be conducted in the next decade.

[구 LiCE-02] Review on the Recent Studies about the Habitability (생명체 거주가능성에 관한 연구 동향)

Sungwook E. Hong (홍성욱), Hyunwoo Kang (강현우), Ryun Young Kwon (권륜영) and LICE team
Korea Astronomy and Space Science Institute (한국천문연구원)

생명체의 거주가능성(habitability)이란, 천체의 물리적인 성질 및 환경에 따라 얼마나 다양한 수준의 생명체가 생겨날 수 있는가를 보는 것이다. 거주가능성은 주로 액체 상태의 물이 고등한 형태의 생명체의 생존에 필수라고 가정하고, 물이 액체 상태에서 안정적으로 존재할 수 있는 항성계의 환경에 관해 연구하게 된다. 본 발표에서는 거주가능성에 관한 해외의 주요 연구 사례에 관해 알아보고, 한국에서는 어떠한 종류의 연구가 가능할지에 관해 논의해 본다. 마지막으로 한국천문연구원의 [우주생명현상탐색] 기획과제에서 제시된 거주가능성 관련 연구 제안을 간략하게 소개한다.

[구 LiCE-03] Current status and Prospect of the Radio SETI

Minsun Kim, Sungwook E. Hong, Taehyun Jung, Hyunwoo Kang, Min-Su Shin, Bong Won Sohn and LiCE team
KASI

Searching for technosignatures is the fundamental tool for finding the evidence of the extraterrestrial life in the Universe along with searching for biosignatures. We summarize the current status of the radio SETI(Search for Extraterrestrial Intelligence) such as the Breakthrough Listen project and suggest a concept of the VLBI SETI with KVN(Korean VLBI Network). In addition, we introduce conceptual studies of the SETI on the surface of Moon's farside and in lunar orbit.

[구 LiCE-04] Discovery and in-depth research on Interstellar Objects

Thiem Hoang
KASI

Interstellar objects (ISOs) provide essential information on the physical and chemical properties of the environment when extrasolar systems are formed. Since 2017, two interstellar objects, 1I/2017 ('Oumuamua) and C/2019 Borisov, have been observed passing our solar system. The first interstellar object, named 1I/2017 ('Oumuamua), exhibits several peculiar properties that cannot be explained based on our knowledge of solar system objects, including extreme

elongation and non-gravitational acceleration. Its nature and origins remain a mystery. In this talk, I will first describe the basic observational properties of `Oumuamua and review various theories proposed to explain these features. I will then present our results, ruling out the most promising proposal that `Oumuamua was made out of molecular hydrogen ice (solid hydrogen). Finally, I will discuss prospects for the detection of ISOs with LSST and in-depth research through multi-wavelength and tracers.

[구 LiCE-05] Maximizing the Probability of Detecting Interstellar Objects by using Space Weather Data (우주기상 데이터를 활용한 성간물체 관측 가능성의 제고)

Ryun Young Kwon, Minsun Kim, Thiem Hoang, and LiCE Team
Korea Astronomy and Space Science Institute
(한국천문연구원)

Interstellar objects originate from other stellar systems. Thus, they contain information about the stellar systems that cannot be directly explored; the information includes the formation and evolution of the stellar systems and the possibility of life. The examples observed so far are 1I/Oumuamua in 2017 and 2I/Borisov in 2019. In this talk, we present the possibility of detecting interstellar objects using the Heliospheric Imagers designed for space weather research and forecasting by observing solar wind in interplanetary space between the Sun and Earth. Because interstellar objects are unpredictable events, the detection requires observations with wide coverage in spatial and long duration in temporal. The near-real time data availability is essential for follow-up observations to study their detailed properties and future rendezvous missions. Heliospheric Imagers provide day-side observations, inaccessible by traditional astronomical observations. This will dramatically increase the temporal and spatial coverage of observations and also the probability of detecting interstellar objects visiting our solar system, together with traditional astronomical observations. We demonstrate that this is the case. We have used data taken from Solar TErrestrial RElation Observatory (STEREO)/Sun Earth Connection Coronal and Heliospheric Investigation (SECCHI) HI-1. HI-1 is off-pointed from the Sun direction by 14 degrees with 20 degrees of the field of view. Using images observed from 2007 to 2019, we have found a total of 223 small objects other than stars, galaxies, or planets, indicative of the potential capability to detect interstellar objects. The same method can be applied to the currently operating missions such as the Parker Solar Probe and Solar Orbiter and also future L5 and L4 missions. Since the data can be analyzed in near-real time due to the space weather purposes, more detailed properties can be analyzed by follow-up observations in ground and space, and also future rendezvous missions. We discuss future possible rendezvous missions at the end of this talk.

[특별세션] Astronomy Cooperation between South and North Koreas

[초 ACSN-01] Cooperation between South Korea and North Korea through wind resource investigation and academic events (북한의 풍력자원 및 학술행사를 통한 협력 방안)

hong-woo Kim (김홍우)
Korea Institute of Energy Reserch
(한국에너지기술연구원)

남,북한에 존재하는 다양한 종류의 신재생에너지 분야 중 풍력자원은 지역마다 많은 편차를 가지고 있으나, 2007년에 북한지역의 풍력자원을 분석한 결과 풍부한 자원을 가지고 있는 지역이 많은 것으로 분석되었다. 북한은 과거에도 그렇고 현재에도 전력난으로 많은 어려움을 겪고 있으며, 이를 극복하기 위하여 북한의 국가과학원, 김일성종합대학, 김책공대 등에서 신재생에너지를 활용한 전력난 해소를 위하여 다양한 기술개발을 하고 있다. 따라서, 성공한 신재생에너지 기술을 활용한 태양광 풍력 등을 설치하여 주택이나 공업지역 등에 전력을 공급하고 있다. 그러나 북한의 자본과 기술개발의 한계로 인하여 부품조달 등 공급의 한계성을 가지고 있는 실정에 있다. 최근 남북 학술교류를 통하여 북한의 신재생에너지 개발 현황 및 한계성을 파악할 수 있었으며, 이러한 문제점을 해결하기 위해서는 남한이 가지고 있는 기술력과 북한의 인력을 활용하여 공동개발 및 보급을 촉진할 수 있으리라 사례되며 몇 가지 제안을 하고자 한다.

[구 ACSN-02] Study on the Cooperation Plan with Astronomical R&D Issues between South and North Korea

Insung Yim, Hong-Jin Yang
Korea Astronomy and Space Science Institute

남한과 북한의 천문 R&D 이슈와 협력 방안에 대해 연구하였다. 지난 2015년 과기부 남북과학기술 및 학술협력사업 '남북한 천문분야 활성화 및 협력방안 연구'를 계기로 북한의 천문연구 현황, 천문관측장비, 인력, 발행물, 책자 등의 자료를 수집하고 정리하였다. 이 자료들은 통일부 북한자료센터와 한국과학기술정보연구원 NK Tech에서 소장한 데이터들, 북한출판사 발행 간행물, 중국국가천문

대, 네덜란드 레이덴 대학에서 보유한 북한 천문 관련 자료, 조선중앙통신과 노동신문과 같은 북한 언론매체 기사, 미국, 캐나다, 독일의 언론에 소개된 기사, 그리고 인터넷을 통해 수집한 자료들이다. 이 자료들을 통해 북한의 천문연구 현황을 이해하고 R&D 이슈는 무엇인지 살펴보려 한다. 또한, 정부와 과학계에서 진행되고 있는 남북한 연구 협력 노력에 대해서도 논의하려 한다. 이를 통해 북한의 천문연구 현황을 이해하고 남북천문협력 방안에 대해서도 제안하려 한다.

[구 ACSN-03] Study on Status of Solar Astronomy in North Korea

Sujin Kim, Hong-Jin Yang, Jong-Kyun Chung, Insung Yim
Korea Astronomy and Space Science Institute, Korea

We present status of solar astronomy in North Korea through analysis of research papers written by North Korea scientists. For the study, we collected 42 papers published in North Korea and international journals. We have analyzed the papers statistically according to three criteria such as research subject, research field, and research members. The main research subjects are the sunspot (28%), observation system (21%), and space environments (19%). The research fields are distributed with data analysis (50%), numerical method (29%), and instrument development (21%). There have been 25 and 9 researchers in the solar astronomy and space environment, respectively since 1995. North Korea's solar research activities were also investigated in three area: instrument, solar physics, and international research linkage. PAO(Pyongyang Astronomical Observatory) has operated two of sunspot telescope and solar horizontal telescope for spectroscopy and polarimetry, but there is no specific information on solar radio telescopes. North Korea has cooperated in solar research with Europe and China. We expect that the results of this study will be used as useful resource in supporting astronomical cooperation between South and North Korea in the future.

[구 ACSN-04] A Study on the North Korea's Astronomical Research based on the Academic Journal

Hong-Jin Yang, Insung Yim
Korea Astronomy and Space Science Institute

북한의 천문학 연구현황을 살펴보기 위해 북한 학자들의 연구 논문을 조사하였다. 북한 평양천문대에서 발행하는 대표적 천문학 학술지인 천문학통보를 비롯해 과학원 통보, 기상과수문 그리고 김일성종합대학학보인 물리학, 자연과학 등의 학술지에 게재된 천문학 논문을 조사하였다. 지난 10년간 북한 학술지에 실린 논문 중 확인된 150여 편 중에서 2015-2018년 천문학통보에 게재된 47편의 논문을 분석하였다. 그 결과 태양 분야 연구가 가장 활발하게 진행되고 있으며 고천문, 인공위성, 항성 등의 연구도 꾸준히 이어지고 있음을 알 수 있다. 북한 학자들의 해외 저널 논문을 조사한 결과 2007-2020년까지 16편을 확인하였다. 평양천문대, 김일성종합대학, 국가과학원 소속의 학자들이 주로 독일이나 중국의 학자들과 공동 논문을 발표하고 있는 것으로 확인된다.

포스터 발 표 초 록

고에너지 천문학/ 이론 천문학

[포 HT-01] Could There Be a Unified Spectral Model for Black Holes and Neutron Stars?

Ayan Bhattacharjee[1], Sandip K. Chakrabarti[2]
[1]*CHEA, UNIST, Korea*
[2]*ICSP, Kolkata, India*

Accretion flows around black holes and neutron stars emit high energy radiation with varying spectral and timing properties. Observed timing variations, both short and long-term, point to the existence of a mechanism, dictated by the flow dynamics, and not by the stellar surface or magnetic fields, that is common in both. Spectral energy distributions of multiple sources indicate that the Comptonization process, the dominant mechanism for changing states in X-ray, takes place inside the flow that has similar physical properties in both the objects. In a series of observational and numerical studies, we enquire about the following: 1. Is there a steady state configuration for accreting matter around black holes that can explain spectral and timing properties? 2. Could a similar formalism explain spectral and timing properties of accretion around neutron stars? 3. Could there be a generalized flow configuration for accreting matter around such compact objects? Furthermore, we show that a unified spectral model can be constructed based on the generalized flow configuration, common to black holes and neutron stars.

[포 HT-02] Properties of polarised emission in radio relics

Paola Domínguez Fernández
Department of Physics, School of Natural Sciences UNIST, Ulsan 44919, Republic of Korea

Radio relics track cosmological shocks propagating through the intracluster medium. They are among the largest and most polarised sources in the radio sky reaching polarisation fractions up to ~60%. High-resolution observations in total intensity and in polarisation show complex structures on kiloparsec scales. Nevertheless, the relation between the observed features and the underlying morphology of the magnetic field is not clear. In this work we three dimensional MHD-Lagrangian simulations to study the polarised emission produced by a shock wave that propagates through a turbulent medium that resembles the intracluster medium. We find that the synchrotron emission produced in a shocked turbulent medium can reproduce some of the observed features in radio relics. Our work confirms that radio relics can also be formed in an environment with a tangled magnetic field. We also study the effect of intrinsic Faraday Rotation and the depolarisation of the source. Finally, we show how our results depend on the angular resolution of observations.

고천문학/ 천문역법

[포 HA-01] Current status of automatic translation service by artificial intelligence specialized in Korean astronomical classics (천문 고문헌 특화 인공지능 자동번역 서비스의 현황)

Yoon Kyung Seo[1], Sang Hyuk Kim[1], Young Sook Ahn[1], Go-Eun Choi[1], Young Sil Choi[1], Hangi Baik[2], Bo Min Sun[2], Hyun Jin Kim[3], Byung Sook Choi[3], Sahng Woon Lee[4], Raejin Park[4]
[1]*Korea Astronomy and Space Science Institute,*
[2]*Institute for the Translation of Korean Classics,*
[3]*NuriIDT Co., Ltd.,* [4]*LLsoLLu Co., Ltd.*

인공지능 기계학습에 의한 한문고전 자동번역기는 승정원일기 뿐만 아니라, 한국 고문헌 중 천문 기록에 특화되어 한자로 된 천문 고전을 한글로 번역해 서비스하고 있다. 한국천문연구원은 한국지능정보사회진흥원이 주관하는 2019년도 Information and Communication Technology 기반 공공서비스 촉진사업에 한국고전번역원과 공동 참여하여 이 자동 번역기 개발을 완료한 것이다. 이 번역기의 개발 목적은 초벌 번역 수준일지라도 문장 형태의 한문을 한글로 자동 번역하는 것이며, 이 연구는 현재 번역기 운용 현황을 서비스 별로 분석하고자 한다. 자동 번역관련 서비스는 크게 3가지이다. 첫째, 누구나 웹 접속을 통해 사용 가능한 한문고전 자동번역 대국민 서비스이다. 1년간 자체 시험을 거쳐 2021년 1월 12일 시험판을 오픈하여 운용 중에 있다. 둘째, 기관별로 구축된 코퍼스와 도메인 특화된 번역 모델 등을 관리할 수 있는 한문고전 자동번역 확산 플랫폼 서비스이다. 대국민 서비스와 함께 클라우드 기반으로 서비스되며, 한국고전번역원이 관리를 담당한다. 셋째, 자동번역 Applied Programmable Interface를 활용한 한국천문연구원 내 자체 활용이 가능한 천문고전 자동번역 서비스이다. 서비스 현황 분석은 기관별 관리 서비스에 해당되는 한문고전 자동번역 확산 플랫폼에서 집계하여 제공하는 대시보드의 통계 기능을 활용한다. 각 서비스별 문장과 파일 번역 이용 건수, 번역 속도, 평균 자수 뿐만 아니라, 번역 모델 프

로필에 따른 이용률 분석이 가능하다. 이에 따른 주요 분석 중 하나인 올해 전체 번역 이용 건수는 한 해 각 기관의 평균 방문자수 대비 87% 성과 목표에 해당되는 약 38만 건에 근접할 것으로 예측된다. 이 자동 번역기는 원문 해독 시간을 단축시키는 효과와 함께 미번역 천문 고문헌의 활용성을 높여 다양한 연구에 기여할 것이다.

==========

※ 이 연구는 과기정통부가 주무부처이며, 한국정보화진흥원이 전문기관인 “2019년도 ICT기반 공공서비스 촉진 사업”중 “클라우드 기반 고문헌 자동번역 확산 서비스 구축 - (부제) 한국천문연구원 천문 분야 고문헌 특화 자동화번역모델 개발”사업에서 수행되었음을 밝힙니다.

[포 HA-02] Analysis of the *Sohyeon-Donggungilgi* Records of Solar Halo Observations

Jaeyeon Hyun[1,2], Byeong-Hee Mihn[1,2], Ki-Won Lee[3], Sang Hyuk Kim[2], Uhn Mee Bahk[2,4]
[1]*Korea University of Science and Technology*
[2]*Korea Astronomy and Space Science Institute*
[3]*Daegu Catholic University*
[4]*Chungbuk National University*

The Donggungilgi (東宮日記) is the daily records of the Siganwon (侍講院), which was a royal office in the Joseon dynasty that took charge of the education for the crown prince who dwelled in the Donggung (East Palace). This literature contains records of meteorological and astronomical observations as well as educational matters. The Sohyeon-Donggungilgi (昭顯東宮日記) includes records from 1625 to 1645, when Prince Sohyeon, the first son of King Injo (仁祖), was the crown prince. We investigate the records of solar halo observations in the Sohyeon-Donggungilgi. For consistency, we restrict our investigation to the period before the second Manchu invasion of Korea (i.e., 1625 to 1635). We extract 2,684 records and classify them into ten events according to the terms in their descriptions. The largest and smallest number of observation records are for the Hun (暈) and Geuk (戟) events (1,794 and 7 records, respectively). To verify what each event represents in modern atmospheric terms, we refer to historical documents of the Seoungwanji (書雲觀志, Treaties on the Bureau of Astronomy) and Cheonmundaeseong (天文大成, Great Achievements in Astronomy). We also calculate the solar altitude based on the observation hour and compare the descriptions to compute simulations provided by Arbeitskreis Meteore e.V.. We find that the descriptions of the Hun, Junghun (重暈), Yi (珥), and Baekhonggwanil (白虹貫日) events indicate a 22° halo, 22° and 46° halos, a parhelion, and a parhelic circle, respectively, Alternatively, we estimate that the Gwan (冠), Dae (戴), Bae (背), Li (履), and Gyohun (交暈) events describe arcs tangent to a 22° or 46° halo such as a upper or lower tangent arc, a circumzenithal arc, or a parry arc. We suggest that further studies are required for the Geuk event because the descriptions of this event differ from both documents referred to this study. In the sense that the number of observation records of the Geuk event is the smallest, however, this event may describe a rare phenomenon. We believe that this work will contribute to the study of historical records of solar or lunar halos.

교육홍보/기타

[포 AE-01] 젊은 천문학자 모임 2019년 활동보고 / Activity of K-YAM in 2019

Seok-Jun Chang[1,3], Sophia Ki[2], Seongjae Kim[3,4], So-Myoung Park[5], Suhyun Shin[2], MiJi Jeong[6], Jisu Kang[2], Yigon Kim[7]
[1]*Department of Physics and Astronomy, Sejong University*
[2]*Department of Physics and Astronomy, Seoul National University*
[3]*Korea Astronomy and Space Science Institute*
[4]*University of Science and Technology*
[5]*School of Space Research, Kyung Hee University*
[6]*Department of Astronomy, Space Science and Geology, Chungnam National University*
[7]*Department of Astronomy and Atmospheric Science, Kyungpook National University*

젊은 천문학자 모임은 한국천문학회의 분과로 국내에서 천문학을 전공하는 대학원생들의 모임입니다. 2019년에 얌은 K-GMT 그룹의 지원을 받아 워크샵을 개최했고 “얌얌 얼굴 좀 보자” 라는 소규모 행사를 진행하여 학생들의 교류에 힘을 썼습니다. 또한 워크샵 기간을 통해 얻은 회원들의 의견으로 학생들의 관측기기 사용을 바탕으로 학생들의 연락망을 구축하여 학술적인 교류를 하고자 합니다. 2019년 4월 12일 제 100회 한국천문학회 봄 학술대회 기간에 열린 정기 총회는 많은 회원들이 모여 활발한 교류를 했습니다. 학술 대회에 이후에 2019 부산과학축전에서 IAU 100주년을 기념하고 2021년에 부산에서 열릴 IAU GA 2021을 홍보하는 한국천문학회 부스에서 회원들이 활동했습니다. 이번 가을 학술대회에는 정기총회에 차기 회장단을 선출하는 선거가 있을 예정이니 많은 분들의 참여 부탁드립니다.

[포 AE-02] Analysis of the *Sohyeon-Donggungilgi* Records of Solar Halo Observations

Jaeyeon Hyun[1,2], Byeong-Hee Mihn[1,2], Ki-Won Lee[3], Sang Hyuk Kim[2], Uhn Mee Bahk[2,4]
[1]*Korea University of Science and Technology*

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

The Donggungilgi (東宮日記) is the daily records of the Siganwon (侍講院), which was a royal office in the Joseon dynasty that took charge of the education for the crown prince who dwelled in the Donggung (East Palace). This literature contains records of meteorological and astronomical observations as well as educational matters. The Sohyeon-Donggungilgi (昭顯東宮日記) includes records from 1625 to 1645, when Prince Sohyeon, the first son of King Injo (仁祖), was the crown prince. We investigate the records of solar halo observations in the Sohyeon-Donggungilgi. For consistency, we restrict our investigation to the period before the second Manchu invasion of Korea (i.e., 1625 to 1635). We extract 2,684 records and classify them into ten events according to the terms in their descriptions. The largest and smallest number of observation records are for the Hun (暈) and Geuk (戟) events (1,794 and 7 records, respectively). To verify what each event represents in modern atmospheric terms, we refer to historical documents of the Seoungwanji (書雲觀志, Treaties on the Bureau of Astronomy) and Cheonmundaeseong (天文大成, Great Achievements in Astronomy). We also calculate the solar altitude based on the observation hour and compare the descriptions to compute simulations provided by Arbeitskreis Meteore e.V.. We find that the descriptions of the Hun, Junghun (重暈), Yi (珥), and Baekhonggwanil (白虹貫日) events indicate a 22° halo, 22° and 46° halos, a parhelion, and a parhelic circle, respectively, Alternatively, we estimate that the Gwan (冠), Dae (戴), Bae (背), Li (履), and Gyohun (交暈) events describe arcs tangent to a 22° or 46° halo such as a upper or lower tangent arc, a circumzenithal arc, or a parry arc. We suggest that further studies are required for the Geuk event because the descriptions of this event differ from both documents referred to this study. In the sense that the number of observation records of the Geuk event is the smallest, however, this event may describe a rare phenomenon. We believe that this work will contribute to the study of historical records of solar or lunar halos.

성간물질/별생성/우리은하

[포 IM-01] Optical spectroscopy of LMC SNRs to reveal the origin of [P II] knots

Rommy L. S. E. Aliste C.[1], Bon-Chul Koo[1], Ji Yeon Seok[2], Yong-Hyun Lee[3]
[1]*Seoul National University*
[2]*Korea Astronomy and Space Science Institute*
[3]*Samsung SDS*

Observational studies of supernova (SN) feedback are limited. In our galaxy, most supernova remnants (SNRs) are located in the Galactic plane, so there is contamination from foreground/background sources. SNRs located in other galaxies are too far, so we cannot study them in detail. The Large Magellanic Cloud (LMC) is a unique place to study the SN feedback due to their proximity, which makes possible to study the structure of individual SNRs in some detail together with their environment.

Recently, we carried out a systematic study of 13 LMC SNRs using [P II] (1.189 μm) and [Fe II] (1.257 μm) narrowband imaging with SIRIUS/IRSF, four SNRs (SN 1987A, N158A, N157B and N206), show [P II]/[Fe II] ratio much higher than the cosmic abundance. While the high ratio of SN 1987A could be due to enhanced abundance in SN ejecta, we do not have a clear explanation for the other cases.

We investigate the [P II] knots found in SNRs N206, N157B and N158A, using optical spectra obtained last November with GMOS-S mounted on Gemini-South telescope. We detected several emission lines (e.g., H I, [O I], He I, [O III], [N II] and [S II]) that are present in all three SNRs, among other lines that are only found in some of them (e.g., [Ne III], [Fe III] and [Fe II]). Various line ratios are measured from the three SNRs, which indicate that the ratios of N157B tend to differ from those of other two SNRs.

We will use the abundances of He and N (from the detection of [N II] and He I emission lines), together with velocity measurements to tell whether the origin of the [P II] knots are SN ejecta or CSM/ISM. For this purpose we have built a family of radiative shock with self-consistent pre-ionization using MAPPINGS 5.1.18, with shock velocities in the range of 100 to 475 km/s. We will compare the observed and modeled line fluxes for different depletion factors.

[포 IM-02] Modeling Grain Rotational Disruption by Radiative Torques and Extinction of Active Galactic Nuclei

Nguyen Chau Giang[1,2] and Thiem Hoang[1,2]
[1]*Korea Astronomy and Space Science Institute, Daejeon 34055, Repulic of Korea*
[2]*Korea University of Science and Technology, Daejeon 34113, Repulic of Korea*

Extinction curves observed toward individual Active Galactic Nuclei (AGN) usually show a steep

rise toward Far-Ultraviolet (FUV) wavelengths and can be described by the Small Magellanic Cloud (SMC)-like dust model. This feature suggests the dominance of small dust grains of size a < 0.1 μm in the local environment of AGN, but the origin of such small grains is unclear. In this paper, we aim to explain this observed feature by applying the RAdiative Torque Disruption (RATD) to model the extinction of AGN radiation from FUV to Mid-Infrared (MIR) wavelengths. We find that in the intense radiation field of AGN, large composite grains of size a > 0.1 μm are significantly disrupted to smaller sizes by RATD up to dRATD > 100 pc in the polar direction and dRATD ~ 10 pc in the torus region.

Consequently, optical-MIR extinction decreases, whereas FUV-near-Ultraviolet extinction increases, producing a steep far-UV rise extinction curve. The resulting total-to selective visual extinction ratio thus significantly drops to RV < 3.1 with decreasing distances to AGN center due to the enhancement of small grains. The dependence of RV with the efficiency of RATD will help us to study the dust properties in the AGN environment via photometric observations. In addition, we suggest that the combination of the strength between RATD and other dust destruction mechanisms that are responsible for destroying very small grains of a <0.05 μm is the key for explaining the dichotomy observed "SMC" and "gray" extinction curve toward many AGN.

[포 IM-03] Catalog of the Paα-emitting Sources observed in the Carina Region

Il-Joong Kim, Jeonghyun Pyo, Woong-Seob Jeong
Korea Astronomy and Space Science Institute

We list up the Paα-emitting sources observed in the Carina Region (l = 276°-296°) using the MIRIS Paα Galactic Plane Survey data. A total of 201 sources are cataloged. Out of them, 118 sources are coincident with those in the WISE H II region catalog. 52 H II region candidates are newly confirmed as definite H II regions by detecting the Paα recombination lines. For the remaining 83 sources, we search the corresponding objects in the SIMBAD database. 26 point-like sources are associated with planetary nebulae or emission-line stars (such as Wolf-Rayet and Blue supergiant stars). Also, we carry out aperture photometry to measure Paα fluxes for the sources that show circular features without overlapping with other bright sources. For the whole Galactic Plane, the complete Paα-emitting source catalog is in progress.

[포 IM-04] Tracing history of the episodic accretion process in protostars

Jaeyeong Kim[1], Jeong-Eun Lee[2], Chul-Hwan Kim[2], Tien-Hao Hsieh[3], Yao-Lun Yang[4], Nadia Murillo[5], Yuri Aikawa[6] and Woong-Seob Jeong[1]
[1]Korea Astronomy and Space Sicence Institute, Daejeon, Korea, [2]Kyung Hee University School of Space Research, Yongin, Korea, [3]Max-Planck-Institute for extraterrestrial Physics, Garching, Germany, [4]The University of Virginia, Department of Astronomy, Charlottesville, US, [5]RIKEN Wako Institute, Saitama, Japan, [6]University of Tokyo, Institute of Astronomy, Tokyo, Japan

Low-mass stars form by the gravitational collapse of dense molecular cores. Observations and theories of low-mass protostars both suggest that accretion bursts happen in timescales of ~100 years with high accretion rates, so called episodic accretion. One mechanism that triggers accretion bursts is infalling fragments from the outer disk. Such fragmentation happens when the disk is massive enough, preferentially activated during the embedded phase of star formation (Class 0 and I). Most observations and models focus on the gas structure of the protostars undergoing episodic accretion. However, the dust and ice composition are poorly understood, but crucial to the chemical evolution through thermal and energetic processing via accretion burst. During the burst phase, the surrounding material is heated up, and the chemical compositions of gas and ice in the disk and envelope are altered by sublimation of icy molecules from grain surfaces. Such alterations leave imprints in the ice composition even when the temperature returns to the pre-burst level. Thus, chemical compositions of gas and ice retain the history of past bursts. Infrared spectral observations of the Spitzer and AKARI revealed a signature caused by substantial heating, toward many embedded protostars at the quiescent phase.

We present the AKARI IRC 2.5-5.0 μm spectra for embedded protostars to trace down the characteristics of accretion burst across the evolutionary stages. The ice compositions obtained from the absorption features therein are used as a clock to measure the timescale after the burst event, comparing the analyses of the gas component that traced the burst frequency using the different refreeze-out timescales. We discuss ice abundances, whose chemical change has been carved in the icy mantle, during the different timescales after the burst ends.

[포 IM-05] Chemical and Kinematic Properties of Sagittarius Stellar Streams

Gwibong Kang[1], Young Sun Lee[2], Young Kwang

Kim[2]
[1]*Department of Astronomy, Space Science, Chungnam National University, Daejeon 34134, South Korea*

We use Sloan Digital Sky Survey, Large Sky Area Multi-Object Fibre Spectroscopic Telescope, and Apache Point Observatory Galactic Evolution Experiment data to analyze the kinematic and chemical properties of stellar members in Sagittarius(Sgr) tidal streams. Using distances, positions, proper motions, and angular momenta of stars around the Sgr streams, we gather clean sample of Sgr member stars. We find that the leading arm has different chemical, kinematic, orbital characteristics from those of the trailing arm and the remnant of Sgr. In particular, the leading arm shows relatively lower eccentricity distribution than the trailing arm, suggesting their origin may differ or they have experienced different dynamical evolution, which is in somewhat mystery.

[포 IM-06] Investigation of heating and accretion event of Milky Way disk

Ayeon Lee[1], Young Sun Lee[2], Young Kwang Kim[2]
[1]*Department of Astronomy, Space Science, and Geology, Chungnam National University, Daejeon 34134, South Korea*
[2]*Department of Astronomy and Space Science, Chungnam National University, Daejeon 34134, South Korea*

We present preliminary results on the chemical and kinematic analysis of accreted and heated metal-rich (-1.0 < [Fe/H] < -0.3) stars in the Galactic disk. These stars are in the ranges of e > 0.7, -100 < V_ϕ < 100 km/s, and |Z| < 3 kpc, and are presumably heated (accreted) by (from) past merger events such as Gaia Enceladus and Sausage (GSE). These stars are largely separated into two groups based on the level of [α/Fe] and radial velocity dispersion. The first group has low [α/Fe] and high radial velocity dispersion, and the second group shows high [α/Fe] and low radial velocity dispersion. We propose that the first group of stars are accreted from the GSE galaxy, whereas the second group of stars are dynamically heated by the GSE merger event.

외부은하/은하단

[포 GC-01] Properties of Shocks in Simulated Merging Clusters

Eunyu Lee[1], Dongsu Ryu[1] and Hyesung Kang[2]
[1]*Department of Physics, College of Natural Sciences, UNIST*
[2]*Department of Earth Sciences, Pusan National University*

Shocks are induced in the intracluster medium by mergers of subclusters during the hierarchical structure formation of the universe. Radio relics detected in the outskirts of galaxy clusters have been interpreted as diffuse synchrotron emission from cosmic ray electrons accelerated at such merger shocks. Using a set of cosmological hydrodynamic simulations, we study how the properties of merger-driven shocks depend on the parameters such as the mass ratio and impact parameter of mergers. In particular, we examine the distribution of the Mach number and energetics of shocks associated with synthetic radio relics in simulated merging clusters. In this poster, we will present the preliminary results and the implications.

[포 GC-02] How to quantify the similarity of 2D distributions: Comparison of spatial distribution of Dark Matter and Intracluster light

Jaewon Yoo[1,2], Jongwan Ko[1,2], Cristiano G. Sabiu[3], Kyungwon Chun[1], Jihye Shin[1], Ho Seong Hwang[4], Rory Smith[1,2], Hyowon Kim[1,2]
[1]*Korea Astronomy and Space Science Institute (KASI),*
[2]*University of Science and Technology (UST),*
[3]*University of Seoul (UoS),*
[4]*Seoul National University (SNU)*

In studying the dynamical evolution of galaxy clusters, one intriguing approach is to compare the spatial distributions of various components, such as the dark matter, the member galaxies, the gas, and the intracluster light (ICL; the diffuse light from stars, which are not bound any individual cluster galaxy). If we find a visible component whose spatial distribution coincides with the dark matter distribution, then we could draw a dark matter map without requiring laborious weak lensing analysis. Furthermore, if the component traces the dark matter distribution better for more relaxed galaxy cluster, we could use the similarity as a dynamical stage estimator of the galaxy cluster. We present a novel new methodology to quantify the similarity of two or more 2-dimensional spatial distributions. We apply the method to a sample of galaxy clusters at different

dynamical stages simulated within N-cluster Run, which is an N-body simulation using the galaxy replacement technique. Among the various components (stellar particles, galaxies, ICL), the velocity defined ICL+ brightest cluster galaxy (BCG) component traces the dark matter best. Between the sample galaxy clusters, the relaxed clusters show stronger similarity of the spatial distribution between the dark matter and ICL+BCG than the dynamically young clusters.

[포 GC-03] Large Scale Structures at z~1 in SA22 Field and Environmental Dependence of Galaxy Properties

Minhee Hyun[1,2], Myungshin Im[2], Jae-Woo Kim[1], Seong-Kook Lee[2], and Insu Paek[2]
[1]Korea Astronomy & Space Science Institute (KASI), [2]SNU Astronomy Research Center (SNUARC), Astronomy Program, Dept. of Physics & Astronomy, Seoul National University (SNU)

We study galaxy evolution with the large-scale environment with confirmed galaxy clusters from multi-object spectroscopy (MOS) observation. The observation was performed with Inamori Magellan Areal Camera and Spectrograph (IMACS) mounted on the 6.5 m Magellan/Baade telescope in Las Campanas Observatory. With the MOS observation, we spectroscopically confirm 34 galaxy clusters, including three galaxy clusters discovered in Kim et al. (2016) and 11 of them have halo mass of > $10^{14.5}$ $M_{\odot}$. Among the confirmed clusters, 12 galaxy clusters are part of large-scale structure at z ~ 0.9, and their size stretches to 40 Mpc co-moving scale. In this study, we checked the 'web feeding model,' which postulates that more linked (with their environment) galaxy clusters have less quenched populations by investigating the correlation between properties of confirmed galaxy clusters and the large-scale structure environment. Lastly, we found that galaxy clusters that make up the large-scale structure have larger and widely spread values of total star formation density ($\Sigma SFR/M_{halo}$) than typical clusters at similar redshifts.

[포 GC-04] Discovery of Massive Galaxy Cluster Candidates in the Southern Sky

Bomi Park[1], Myungshin Im[1], Joonho Kim[1], Minhee Hyun[1], Seong-Kook Lee[1], Jae-Woo Kim[2]
[1]SNU Astronomy Research Center, Department of Physics and Astronomy, Seoul National University, Seoul 08826, Korea
[2]Korea Astronomy and Space Science Institute, Daejeon 34055, Korea

Galaxy clusters are the largest structures in the universe located at the top of the cosmological hierarchical model, so the evolution of the universe can be understood by studying clusters of galaxies. Therefore, finding a larger number of galaxy clusters plays an important role in exploring how the universe evolves. A large number of catalogs for galaxy clusters in the northern sky have been published; however, there are few catalogs in the southern sky due to the lack of wide sky survey data. KMTNet Synoptic Survey of Southern Sky(KS4) project, which observes a wide area of the southern sky about 7000 deg^2 with KMTNet telescopes for two years, is in progress under the SNU Astronomy Research Center. We use the KS4 multi-wavelength optical data and measure photometric redshifts of galaxies for finding galaxy clusters at redshift z<1. Currently, the KS4 project has observed approximately 50% of the target region, and a pipeline that measures photometric redshifts of galaxies has been created. When the project is completed, we expect to find more than a hundred thousand galaxy clusters, and this will improve the study of galaxy clusters in the southern sky.

[포 GC-05] HI superprofiles of galaxies from THINGS and LITTLE THINGS

Minsu Kim[1], Se-Heon Oh[2]
[1]Department of Astronomy and Space Science, Sejong University, Seoul, Korea
[2]Department of Physics and Astronomy, Sejong University, Seoul, Korea

We present a novel profile stacking technique based on optimal profile decomposition of a 3D spectral line data cube, and its performance test using the HI data cubes of sample galaxies from HI galaxy surveys, THINGS and LITTLE THINGS. Compared to the previous approach which aligns all the spectra of a cube using their central velocities derived from either moment analysis, single Gaussian or hermite h3 polynomial fitting, the new method makes a profile decomposition of the profiles from which an optimal number of single Gaussian components is derived for each profile. The so-called superprofile which is derived by co-adding all the aligned profiles from which the other Gaussian models are subtracted is found to have weaker wings compared to the ones constructed in a typical manner. This could be due to the reduced number of asymmetric profiles in the new method. A practical test made on the HI data cubes of the THINGS and LITTLE THINGS galaxies shows that our new method can extract more mass of kinematically cold HI components in

the galaxies than the previous results. Additionally, we fit a double Gaussian model to the superprofiles whose S/N is boosted, and quantify not only their profile shapes but derive the ratio of the Gaussian model parameters, such as the intensity ratio and velocity dispersion ratio of the narrower and broader Gaussian components. We discuss how the superprofile properties of the sample galaxies are correlated with their other physical properties, including star formation rate, stellar mass, metallicity, and gas mass.

[포 GC-06] HI gas properties of BAT-BASS AGN host galaxies

Jeein Kim[1] Aeree Chung[1], Junhyun Baek[1], Kyuseok Oh[2], O. Ivy Wong[3], Michael J. Koss[4,5], and BASS team
[1]*Yonsei University*
[2]*Korea Astronomy and Space Science Institute (KASI)*
[3]*Commonwealth Scientific and Industrial Research Organisation (CSIRO)*
[4]*Eureka Scientific*
[5]*Space Science Institute*

We present preliminary results of the○ VLA archival HI data of local AGN hosts. The sample consists of the galaxies selected from the Swift-BAT hard X-ray survey. The main goal is to probe the gas environment of the sample in order to verify the role of gas accretion as one of the major AGN triggering mechanisms. HI, as a mostly diffuse and extended gas component in many galaxies, is a sensitive tracer to explore the impact of the surroundings on galaxies. In this work, we therefore probe the HI imaging data of a subsample of BAT-BASS AGN hosts, starting with the cases for which relatively high HI fluxes have been reported from the past single-dish observations. Based on their resolved HI properties, we will discuss the possibility of gas accretion and its role in powering AGNs in these examples.

[포 GC-07] Compact Elliptical Galaxies Hosting Active Galactic Nuclei in Isolated Environments

Soo-Chang Rey[1], Kyuseok Oh[2], and Suk Kim[1]
[1]*Department of Astronomy and Space Science, Chungnam National Nuniversity (CNU),* [2]*Korea Astronomy and Space Science Institute (KASI)*

We present the discovery of rare active galactic nuclei (AGNs) in nearby (z<0.05) compact elliptical galaxies (cEs) located in isolated environments. Using spectroscopic data from the Sloan Digital Sky Survey (SDSS) Data Release 12, four AGNs were identified based on the optical emission-line diagnostic diagram. SDSS optical spectra of AGNs show the presence of distinct narrow-line emissions. Utilizing the black hole (BH) mass-stellar velocity dispersion scaling relation and the correlation between the narrow L([OIII])/L(Hβ) line ratio and the width of the broad Hα emission line, we estimated the BH masses of the cEs to be in the range of 7×10^5–8×10^7 solar mass. The observed surface brightness profiles of the cEs were fitted with a double Sérsic function using the Dark Energy Camera Legacy Survey r-band imaging data. Assuming the inner component as the bulge, the K-band bulge luminosity was also estimated from the corresponding Two Micron All Sky Survey images. We found that our cEs follow the observed BH mass-stellar velocity dispersion and BH mass-bulge luminosity scaling relations, albeit there was a large uncertainty in the derived BH mass of one cE. In view of the observational properties of BHs and those of the stellar populations of cEs, we discuss the proposition that cEs in isolated environments are bona fide low-mass early-type galaxies (i.e., a nature origin).

[포 GC-08] Star-forming Dwarf Galaxies in Filamentary Structures around the Virgo Cluster

Soo-Chang Rey[1], Jiwon Chung[2], Suk Kim[1], and Youngdae Lee[1]
[1]*Department of Astronomy and Space Science, Chungnam National Nuniversity (CNU),* [2]*Korea Astronomy and Space Science Institute (KASI)*

We present the chemical properties of star-forming dwarf galaxies (SFDGs) in five filamentary structures (Leo II A, Leo II B, Leo Minor, Canes Venatici, and Virgo III) around the Virgo cluster using the Sloan Digital Sky Survey optical spectroscopic data and Galaxy Evolution Explorer ultraviolet photometric data. We investigate the relationship between stellar mass, gas-phase metallicity, and specific star formation rate (sSFR) of SFDGs in the Virgo filaments in comparison to those in the Virgo cluster and field. We find that, at a given stellar mass, SFDGs in the Virgo filaments show lower metallicity and higher sSFR than those in the Virgo cluster on average. We observe that SFDGs in the Virgo III filament show enhanced metallicities and suppressed star formation activities comparable to those in the Virgo cluster, whereas SFDGs in the other four filaments exhibit similar properties to the field counterparts. Moreover, about half of the galaxies in the Virgo III filament are found to be morphologically transitional dwarf galaxies that are

supposed to be on the way to transforming into quiescent dwarf early-type galaxies. Based on the analysis of the galaxy perturbation parameter, we propose that the local environment represented by the galaxy interactions might be responsible for the contrasting features in "chemical pre-processing" found in the Virgo filaments.

[포 GC-09] HI gas kinematics of paired galaxies in the cluster environment from ASKAP pilot observations

Shin-Jeong Kim[1], Se-Heon Oh[2]★, Minsu Kim[1], Hye-Jin Park[2], Shinna Kim[1], and ASKAP WALLABY Science Working Group[2] (SWG2)
[1]*Department of Astronomy and Space Science, Sejong University, Seoul, Korea*
[2]*Department of Physics and Astronomy, Sejong University, Seoul, Korea*
★corresponding author: seheon.oh@sejong.ac.kr

We examine the HI gas kinematics and distributions of galaxy pairs in group or cluster environments from high-resolution Australian Square Kilometer Array Pathfinder (ASKAP) WALLABY pilot observations. We use 32 well-resolved close pair galaxies from the Hydra, Norma, and NGC 4636, two clusters and a group of which are identified by their spectroscopy information and additional visual inspection. We perform profile decomposition of HI velocity profiles of the galaxies using a new tool, BAYGAUD which allows us to separate a line-of-sight velocity profile into an optimal number of Gaussian components based on Bayesian MCMC techniques. Then, we construct super profiles via stacking of individual HI velocity profiles after aligning their central velocities. We fit a model which consists of double Gaussian components to the super profiles, and classify them as kinematically cold and warm HI gas components with respect to their velocity dispersions, narrower or wider σ, respectively. The kinematically cold HI gas reservoir (M_cold/M_HI) of the paired galaxies is found to be relatively higher than that of unpaired control samples in the clusters and the group, showing a positive correlation with the HI mass in general. Additionally, we quantify the gravitational instability of the HI gas disk of the sample galaxies using their Toomre Q parameters and HI morphological disturbances. While no significant difference is found for the Q parameter values between the paired and unpaired galaxies, the paired galaxies tend to have larger HI asymmetry values which are derived using their moment0 map compared to those of the non-paired control sample galaxies in the distribution.

[포 GC-10] Gas dynamics and star formation in NGC 6822

Hye-Jin Park[1], Se-Heon Oh[1], Jing Wang[2], Yun Zheng[2], Hong-Xin Zhang[3,4], and W.J.G. de Blok[5,6,7]
[1]*Department of Physics and Astronomy, Sejong University, Seoul, Korea*
[2]*Kavli Institute for Astronomy and Astrophysics (KIAA), Peking University, Beijing, China*
[3]*Key Laboratory for Research in Galaxies and Cosmology, Department of Astronomy, University of Science and Technology of China, Hefei, China*
[4]*School of Astronomy and Space Science, University of Science and Technology of China, Hefei, China*
[5]*Netherlands Institute for Radio Astronomy (ASTRON), Dwingeloo, The Netherlands*
[6]*Department of Astronomy, University of Cape Town, Rondebosch, South Africa*
[7]*Kapteyn Astronomical Institute, University of Groningen, Groningen, The Netherlands*

We examine gas kinematics and star formation activities of NGC 6822, a gas-rich dwarf irregular galaxy in the Local Group at a distance of ~490 kpc. We perform profile decomposition of all the line-of-sight (LOS) HI velocity profiles of the high-resolution (42.4" x 12" spatial; 1.6 km/s spectral) HI data cube of the galaxy, taken with the Australian Telescope Compact Array (ATCA). To this end, we use a novel tool based on Bayesian Markov Chain Monte Carlo (MCMC) techniques, the so-called BAYGAUD, which allows us to decompose a velocity profile into an optimal number of Gaussian components in a quantitative manner. We group all the decomposed components into bulk-narrow, bulk-broad, and non-bulk gas components classified with respect to their velocity dispersions and the amounts of velocity offset from the global kinematics, respectively. Using the surface densities and velocity dispersions of the kinematically decomposed HI gas maps together with the rotation curve of NGC 6822, we derive Toomre-Q parameters for individual regions of the galaxy which quantify the level of local gravitational instability of the gaseous disk. We also measure the local star formation rate (SFR) of the corresponding regions in the galaxy by combining GALEX Far-ultraviolet (FUV) and WISE 22μm images. We then relate the gas and SFR surface densities in order to investigate the local Kennicutt-Schmidt (K-S) law of gravitationally unstable regions which are selected from the Toomre Q analysis. Of the three groups, the bulk-narrow, bulk-broad and non-bulk gas components, we find that the lower Toomre-Q values the bulk-narrow gas components have, the more consistent with the linear extension of the

K-S law derived from molecular hydrogen (H2) observations.

[포 GC-11] High-resolution mass models of the Large Magellanic Cloud

Shinna Kim[1], Se-Heon Oh[2★], Bi-Qing For[3] and Yun-Kyeong Sheen[4]

[1]*Department of Astronomy and Space Science, Sejong University, Seoul, Korea*
[2]*Department of Physics and Astronomy, Sejong University, Seoul, Korea*
[3]*International Centre for Radio Astronomy Research (ICRAR), University of Western Australia, Crawley, Australia*
[4]*Korea Astronomy and Space Science Institute, Daejeon, Korea*
★corresponding author: seheon.oh@sejong.ac.kr

We perform disk-halo decomposition of the Large Magellanic Cloud (LMC) using a novel HI velocity field extraction method, aimed at better deriving its HI kinematics and thus mass distribution in the galaxy including both baryons and dark matter. We decompose all the line-of-sight velocity profiles of the combined HI data cube of the LMC, taken from the Australia Telescope Compact Array (ATCA) and Parkes radio telescopes with an optimal number of Gaussian components. For this, we use a novel tool, the so-called BAYGAUD which performs profile decomposition based on Bayesian MCMC techniques. From this, we disentangle turbulent non-ordered HI gas motions from the decomposed gas components, and produce an HI bulk velocity field which better follows the global circular rotation of the galaxy. From a 2D tilted-ring analysis of the HI bulk velocity field, we derive the rotation curve of the LMC after correcting for its transverse, nutation and precession motions. The dynamical contributions of baryons like stars and gaseous components which are derived using the Spitzer 3.6 micron image and the HI data are then subtracted from the total kinematics of the LMC. Here, we present the bulk HI rotation curve, the mass models of stars and gaseous components, and the resulting dark matter density profile of the LMC.

[포 GC-12] Searching for Spectrally Variable AGNs using Multi-epoch Spectra from SDSS

Jiyeon Seong[1], Minjin Kim[1], Dong-Chan Kim[2], Il-Sang Yoon[2], Jaejin Shin[1]
[1]*Department of Astronomy and Atmospheric Science, Kyungpook National University,* [2]*National Radio Astronomy Observatory*

Using multi-epoch spectra of active galactic nuclei (AGN) obtained from the Sloan Digital Sky Survey, we identify 16 spectrally variable sources, for which the spectral shapes of broad emission lines significantly vary with a time scale of yrs. Out of them, 3 AGNs are already known as changing-look (CL) AGNs by previous studies. 6 AGNs are newly identified as CL AGNs from our study. A majority of these AGNs are relatively faint and their variability in the continuum is small, which may explain their non-detection in the previous studies. 7 sources are known as binary AGN candidates based on the systematic velocity offset between broad emission lines and narrow emission lines. For those sources and 3 CL AGNs, we find that the peak of broad emission lines had been shifted up to a few thousands km/s for ~10 years, implying that those can be promising candidates for pc-scale binary AGNs or recoiling black holes. We plan to conduct multiwavelength follow-up studies to nail down the physical origin of the velocity shift.

[포 GC-13] The strategy to catch more early light curves of supernovae

Jeeun Hwang, Myungshin Im, Gregory S.H. Paek, and IMSNG team
SNU Astronomy Research Center

The Intensive Monitoring Survey of Nearby Galaxies (IMSNG) is a high cadence observation program monitoring nearby galaxies at < 50 Mpc with high probabilities of hosting supernovae (SNe). The current number of main IMSNG targets is 60, but with new wide-field facilities joining IMSNG, there is a possibility of increasing the likelihood of catching the early light curves of SNe among galaxies in the vicinity of the main targets. To test the feasibility of the expansion of the sample galaxies, we examine how much the probability of catching SNe increases by adjusting the field of view of the RASA36 telescope which is one of the IMSNG facilities with a large field of view of 6.25 deg2. We calculate supernova rates (SNRs) of galaxies within the FoV that contains main IMSNG galaxies from the stellar mass and star formation rate of the galaxies. Based on the SNRs of these galaxies, we find the best pointing of the telescope towards the highest SNR region. As a result, we present improved total SNR, with respect to the ordinary pointing on average where the IMSNG main target is placed at the center of FoV. The actual observation should be followed to test the effect of this strategy.

[포 GC-14] Merging histories of Galaxies in Deep and Wide Images of 7 Abell Clusters with Various Dynamical States

Duho Kim[1], Yun-Kyeong Sheen[1], Yara L. Jaffe[2], Adarsh Ranjan[1], Sukyoung K. Yi[3] and Rory Smith[1]
[1]Korea Astronomy and Space Science Institute, Daedeokdae-ro 776, Yuseoung-gu Daejeon 34055, Republic of Korea, [2]Instituto de Fisica y Astronomia, Universidad de Valparaiso, Avda. Gran Bretana 1111 Valparaiso, Chile, [3]Yonsei University, Republic of Korea

Galaxy mergers are known to have been one of the main drivers in galaxy evolution in a wide range of environments. However, in galaxy clusters, high-speed encounters have been believed to undermine the role of mergers as a driver in galaxy evolution. Nonetheless, a high fraction (~38% in Sheen et al. 2012 and ~20% in Oh et al. 2018) of galaxies with post-merging features have been reported in deep (>~28 mag/arcsec2) optical surveys of cluster galaxies. The authors argue that these galaxies could have merged outside of the cluster and, later, fallen into the cluster, sustaining their long-lasting post-merging features. On the other hand, when galaxy clusters interact, galaxy orbits might be destabilized resulting in a higher galaxy merger rate. To test this idea, we measure the ongoing-merger fraction of galaxies in deep DECam mosaic data of seven Abell clusters (A754, A2399, A2670, A3558, A3574, A3659 and A3716) with a variety of dynamical states ($0.016<z<0.091$) for comparison with the ongoing-merger fraction (~4%) from virialized clusters in the literature. We also publish our photometric catalogues of DECam mosaics centered on these clusters in u, g, and r-band.

우주론/암흑물질,암흑에너지

[포 CD-01] Probing the Early Phase of Reionization through LiteBIRD

Kyungjin Ahn[1], Hina Sakamoto[2], Kiyotomo Ichiki[2], Hyunjin Moon[1], Kenji Hasegawa[2]
[1]Chosun University
[2]University of Nagoya

Cosmic reionization imprints its history on the sky map of the cosmic microwave background (CMB) polarization. Even though mild, the signature of the reionization history during its early phase ($z>15$) can also impact the CMB polarization. We forecast the observational capability of the LiteBIRD(Lite(Light) satellite for the studies of B-mode polarization and Inflation from cosmic background Radiation Detection), a truly cosmic-variance limited apparatus. We focus on the capability for such an apparatus to probe the partial optical depth of the CMB photons during $z>15$. We show that LiteBIRD is able to probe this quantity with a modest to high significance, enabling one to tell how efficient the cosmic reionization and star formation were at $z>15$.

[포 CD-02] Detecting the Baryon Acoustic Oscillations in the N-point Spatial Statistics of SDSS Galaxies

Se Yeon Hwang, Sumi Kim, Cristiano G. Sabiu, In Kyu Park
Department of Physics, University of Seoul, Seoul 02504, Republic of Korea

Baryon Acoustic Oscillations (BAO) are caused by acoustic density waves in the early universe and act as a standard ruler in the clustering pattern of galaxies in the late Universe. Measuring the BAO feature in the 2-point correlation function of a sample of galaxies allows us to estimate cosmological distances to the galaxies mean redshift, $<z>$, which is important for testing and constraining the cosmology model. The BAO feature is also expected to appear in the higher order statistics. In this work we measure the generalized spatial N-point point correlation functions up to 4th order.

We made measurements of the 2, 3, and 4-point correlation functions in the SDSS-III DR12 CMASS data, comprising of 777,202 galaxies. The errors and covariances matrices were estimated from 500 mock catalogues. We created a theoretical model for these statistics by measuring the N-point functions in halo catalogues produced by the approximate Lagrangian perturbation theory based simulation code, PINOCCHIO. We created simulations using initial conditions with and without the BAO feature. We find that the BAO is detected to high significance up to the 4-point correlation function.

교육홍보, 기타

[포 CD-01] Academic exchange and social activity of Korea young astronomers meeting

(KYAM) in the COVID-19 era

신수현 (Suhyun Shin)[1], 정미지 (Migi Jeong)[2], 문병하 (Byeongha Moon)[3,7], 문정인 (Jeongin Moon)[4], 손수연 (Suyeon Son)[5], 오성아 (Seong-A O)[1], 이시은 (Sieun Lee)[6]
[1]서울대학교 (Seoul National University),
[2]충남대학교(Chungnam National University),
[3]UST(University of Science & Technology),
[4]세종대학교(Sejong University),
[5]경북대학교(Kyungpook National University),
[6]경희대학교(Kyung Hee University),
[7]한국천문연구원(Korea Astronomy and Space Science Institute)

한국 젊은 천문학자 모임(Korea Young Astronomers Meeting, KYAM)은 국내 젊은 천문학자들의 학술 교류 및 친목을 도모하는 단체로, 대면 중심의 활동이 큰 비중을 차지하고 있었습니다. 그러나, 코로나 사태가 장기화되면서 비대면 활동의 중요성이 매우 커졌습니다. 따라서, 2021년도 KYAM 운영진은 다양한 비대면 활동을 준비하여 KYAM의 본 목적을 성취하고자 노력하였습니다.

그 일환으로 젊은 천문학자들간의 연구 교류 활성화를 위해 매달'얌마당'이라는 독자적인 대학원생 콜로퀴움을 진행하고 있습니다. 그뿐만 아니라 KYAM 회원들간의 오픈 카카오톡방을 개설하여 시간과 공간의 제약을 뛰어넘어 친목을 다지고 연구 교류를 할 수 있는 장을 마련하였습니다. 이외에도 비대면 모임을 개최하고 KYAM 설립 30주년 기념으로 로고 공모전을 여는 등 코로나 시대에 발맞춘 KYAM의 활동을 본 포스터를 통해 소개하고자 합니다.

[포 CD-02] Recent progress in astronomy education in Makerspace situation

Yonggi Kim(김용기), Hyoungbum Kim(김형범),
CBNU

본 연구는 지능정보기술을 천문교육에 활용하여 어떻게 천문교육에 활용할 것인가에 대한 방안을 모색해보았다. 3D프린터, 레이저커팅기, 빅데이터, 인공지능, 드론 등 지능정보기술을 확보한 메이커스페이스 공간에서 이들 기술을 활용하여 천문교육 프로그램을 개발해보는 일은 4차산업혁명시대의 핵심역량을 함양하는데 크게 기여할 것으로 판단된다. 또한 2021년 8월에 중기부 사업으로 선정된 충북대 Pro 메이커스 센터를 중심으로 메이커스페이스 환경에서 다양한 천문교구 개발 및 개발된 천문교구를 활용한 프로그램이 개발되어 형식교육의 현장 뿐만 아니라 비형식 교육의 현장에 다양하게 적용될 계획이다. 이에 향 후 메이커스페이스 환경에서 대중천문프로그램이 어떻게 발전될 것인가에 대한 견해 및 토론도 발표될 예정이다.

[포 CD-03] Application and Development of astronomical STEAM program for Science Culture and Creative Education

Harim Kim(김하림)[1], Hyoungbum Kim(김형범)[1]
Ah-Chim Sul(설아침)[2]
[1]Chungbuk National University, [2]KASI

이 연구의 목적은 PEST 방법론을 적용한 STEAM 프로그램 개발 및 적용에 대한 효과성을 알아보는 창의교육을 위한 연구이다. 특히, 이 연구는 과학문화 소외지역에 대한 이동천문대 활용 STEAM 프로그램을 개발하여 이에 대한 학생들의 수업효과 및 만족도를 알아보는 연구로, 과학 문화에 소외된 지역의 학생들에게 천문에 대한 흥미를 주어 향후 천문과학의 올바른 과학적 개념을 이해하고 미래 직업으로서 천문관련 분야에 관심을 갖도록 하는 데 있다. 이 연구에서 개발한 STEAM 프로그램은 관련분야 전문가 5명이 한국천문연구원을 통해 이동천문대 교육 프로그램에 대한 지속적인 연구와 PEST 방법론 적용 및 소외지역에 대한 현장 적합성 연구를 5회의 워크숍과 전문가 타당화회의와 Pilot test를 통해 최종 STEAM 프로그램을 개발하였다. 이 연구에서 개발된 STEAM 프로그램의 적용 결과는 다음과 같다. 첫째, 이 연구에서 개발된 이동천문대는 모든 학생들에게 천문에 대한 호기심을 자극하는 긍정적인 효과를 나타내었다. 둘째, 이 프로그램은 총 11시간의 PEST 방법을 적용한 프로그램으로, '상황제시 1차시, 감성적 체험 5차시, 창의적 설계 5차시로 구성되어 과학문화 소외지역 학생들에게 높은 수업 만족도를 나타내었다. 따라서 PEST 방법을 적용한 이동천문대 STEAM 프로그램은 학습자의 천문과학에 대한 과학적 소양과 과학적 본성을 불러일으키는데 매우 긍정적인 효과를 나타낼 것으로 사료되며, 추후 연구에서 다양한 학년과 지역 및 위계에 따른 프로그램의 개발과 적용될 필요가 있다.

[포 CD-04] An Oral History Study of Overseas Korean Astronomer: John D. R. Bahng's Case
한국천문연구원 원외 원로 구술사연구
- 방득룡 전임 노스웨스턴 대학교 천문학 교수 사례 -

Youngsil Choi[1], Yoon Kyung Seo[1], Hyung Mok Lee[1,2]
[1]Korea Astronomy and Space Science Institute,
[2]Seoul National University

한국천문연구원은 2017년 제1차 구술채록사업에 이어 2020년 제2차 사업을 진행하면서 최초로 원외 원로에 대한 구술채록을 시도하였다. 국가 대표 천문연구의 산실로서 연구원 존재 의의를 확립하기 위하여 원내 원로에 국한되었던 구술자 대상을 확장한 것이다.

그 첫 외부 구술 대상자로 방득룡 전임 노스웨스턴 천문학과 교수를 선정하여 2020년 7월부터 준비단계에 들어갔다. 방득룡 前교수가 첫 번째 한국천문연구원 원외 인사 구술자로 선정된 이유는, 그가 우리나라 천문대1호 망원경 구매 선정에 개입한 서신(1972년)이 자료로 남아있었기 때문이다. 한국천문연구원에서 2017년에 수행한 제1차 구술채록사업에서 구술자로 참여한 오병렬 한국천문연구원 원로가 기증한 사료들은 대부분 연구원 태동기 국립천문대 구축과 망원경 구매 관련 자료였으며 이 가운데 1972년 당시 과학기술처 김선길 진흥국장에게 Boller and Chivesns(社)의 반사경을 추천한 방득룡 前교수의 서신은 한국 천문학 발전사에서 중요한 사료였다. 연구진은 이 자료를 시작으로, 방득룡 前교수의 생존 여부와 문서고의 공기록물들에서 그의 흔적을 찾아가기 시작했다.

놀랍게도 그는 실제 세계와 한국천문연구원 문서고 깊숙이 기록물들 모두에서 상존하고 있었다. 1927년생인 방득룡 前교수, Dr. John D. R.은 미국 플로리다 한 실버타운에서 건강한 정신으로 생존하여 있었고 연구진의 인터뷰에 흔쾌히 응했다.

2020년 9월 16일에 한국천문연구원 본원 세종홀 2층 회의실에서 영상통신회의로 그와의 구술인터뷰가 진행되었다. 이 구술인터뷰는 원외 인사가 대상이란 점 외에도 방법적으로는 전형적인 대면 방식이 아닌 영상 인터뷰였다는 점에서 코로나 시대의 대안이 되는 실험적 시도였다. 현대 한국천문학 발전사의 재조명 측면에서도 의미가 있었다. 1960년대 초반부터 1992년 정년퇴임까지 30년을 미국 유수 대학교 천문학과 교수로 재직하며 활발한 활동을 해 온 한국계 천문학자가 우리나라 최초 반사망원경 구매 선정에 적극 개입하였던 역사는, 공문서 자료들과 서신 사료들에 이어 그의 육성으로 나머지 의구심의 간극이 채워졌다. 또 구술자 개인이 주관적으로 중요하다고 여기는 '기억'이 중요한 아카이빙 콘텐츠 확장의 단초가 될 수 있다는 것을 보여줌으로써 구술사 연구에 있어서도 중요한 관점을 주었다.

애초 연구진이 방득룡 前교수의 공식 기록에서 아카이빙의 큰 줄기로 잡았던 것은 1948년 도미, 1957년 위스콘신 대학교 천문학 박사학위 취득, 1962년부터 노스웨스턴 대학(일리노이주 에반스턴)의 천문학 교수진, 1992년 은퇴로 이어진 생애였다. 그러나 그와의 구술 준비 서신 왕래와 구술을 통하여 알게 된 그가 인생에서 중요시 여겼던 지점은, 1948년 도미 무렵 한국의 전쟁 전 상황과 당시 비슷한 시기에 유학한 한국 천문학자들의 동태, 그리고 1957년부터 1962년까지 프린스턴 대학교에서 M. Schwarzschild 교수와 L. Spitzer 교수를 보조하며 Stratoscope Project를 연구하였던 경험이었다. 기록학적 의미에서도, 전자를 통해서 그와 함께 동시대 한국 천문학을 이끌었던 인재들의 맥락정보를 얻을 수 있었으며, 후자를 통해서는 세계 천문학사에 큰 영향을 미친 석학에 대한 아카이브 정보와의 연계 지점과 방득룡 前교수의 연구 근원을 찾을 수 있었다. 이들은 추후 방득룡 콘텐츠 서비스 시에 AIP, NASM, Lyman Spitzer 콘텐츠, 평양천문대, 화천조경천문대, 서울대와 연세대, 그리고 한국천문연구원까지 연계되어 전 세계 폭넓은 이용자들의 유입을 유도할 수 있는 검색 도구가 될 수 있다.

이번 방득룡 구술사 연구에서 구술자 개인의 주관적인 소회가 공식 기록이 다가갈 수 없는 역사적 실체에 일정 부분 가까울 수 있다는 것, 그리고 이를 통하여 개인의 역사는 공동체의 역사로 확장될 수 있다는 사실을 발견할 수 있었다. 또 연구진은 방득룡 前교수의 회상을 통하여 구술자 개인의 시각으로 한국과 미국 천문학계의 공동체 역사를 재조명할 수 있었고, 이것을 아카이브 콘텐츠 확장 서비스에 반영할 수 있다는 기대를 가지게 되었다. 무엇보다 이 연구를 통하여 다양한 주제의 아카이브로 연동될 수 있는 주제어와 검색도구를 구술자 개인의 회상으로부터 유효하게 도출할 수 있다는 것을 확인하였다. 그리고 향후 한국천문 구술아카이브의 확장을 통하여 보다 다양한 활용과 연구 재활용의 선순환이 가능하다는 것도 알 수 있었다. 이는 최근 기록학계에서 대두되고 있는 LOD(Linked Open Data)의 방향성과도 흡사하여 한국천문학 구술사연구의 차세대 통합형 기록관리의 미래모형을 기대케 하는 대목이다.

* 이 연구는 2020년 한국천문연구원 원장실에서 기획하고 원장실과 기록관에서 진행한 제1차 원외 원로 구술채록사업을 대상으로 하였고, 『천문우주정보 및 지식확산 연차실적계획서』(한국천문연구원, 대전, 2019)에 실은 연구결과의 일부 내용을 구체화한 것임을 밝힙니다.

천문화학/천문생물학

[포 AB-01] Discovery of C_2 Swan Band and CN emission in Spark Discharge Experiment

In-Ok Song[1], Younghoon Mo[1,2], Jein Ryu[1,3], Hoyon Chang[1,2], Ki-Wook Hwang[1,3], Man-Seog Chun[1], Jinho Oh[1], Sangjoon Hahn[1]
[1]*Korea Science of Academy of KAIST*
[2]*Seoul National University*
[3]*KAIST*

밀러-유리 실험으로 알려진 전기방전 실험은 지구초기 대기를 모사하여 아미노산을 합성하여, 지구에서 생명의 기원을 연구하는 실험중의 하나이다. 메탄(CH_4), 암모니아(NH_3), 질소(N_2) 가스를 주입하고 전기방전으로 에너지를 가했다. 그 결과 용액에서는 아미노산인 글라이신($C_2H_5NO_2$), 알라닌($C_3H_7NO_2$), 히스티딘($C_6H_9N_3O_2$), 프롤린($C_5H_9NO_2$), 발린($C_5H_{11}NO_2$)이 검출되었고, 기존 Miller 1953과 Parker et al. 2014의 결과와 비교하였다. 전기방전에서는 C_2 Swan Band 와 CN emission을 발견하였다. 이 두 방출선들은 혜성에서도 일반적으로 보여지는 방출선들이다.

천문우주관측기술

[포 AT-01] Deep learning classification of transient noises using LIGOs auxiliary channel data

SangHoon Oh[1], Whansun Kim[1], Edwin J. Son[1], and Young-Min Kim[2]
[1]*National Institute for Mathematical,* [2]*UNIST*

We demonstrate that a deep learning classifier that only uses to gravitational wave (GW) detectors auxiliary channel data can distinguish various types of non-Gaussian noise transients (glitches) with significant accuracy, i.e., $\gtrsim$ 80%. The classifier is implemented using the multi-scale neural networks (MSNN) with PyTorch. The glitches appearing in the GW strain data have been one of the main obstacles that degrade the sensitivity of the gravitational detectors, consequently hindering the detection and parameterization of the GW signals. Numerous efforts have been devoted to

tracking down their origins and to mitigating them. However, there remain many glitches of which origins are not unveiled. We apply the MSNN classifier to the auxiliary channel data corresponding to publicly available GravitySpy glitch samples of LIGO O1 run without using GW strain data. Investigation of the auxiliary channel data of the segments that coincide to the glitches in the GW strain channel is particularly useful for finding the noise sources, because they record physical and environmental conditions and the status of each part of the detector. By only using the auxiliary channel data, this classifier can provide us with the independent view on the data quality and potentially gives us hints to the origins of the glitches, when using the explainable AI technique such as Layer-wise Relevance Propagation or GradCAM.

[포 AT-02] Development progress in the Maunakea Spectroscopic Explorer's Exposure Time Calculator (MSE-ETC)

Taeeun Kim[1], Changgon Kim[1], Tae-Geun Ji[1], Hojae Ahn[1], Mingyeong Yang[1], Soojong Pak[1], Sungwook E. Hong[2], Jennifer Sobeck[3,4], Kei Szeto[3,4], Jennifer Marshall[3,5], Christian Surace[3,6]
[1]Kyung Hee University
[2]Korea Astronomy and Space Science Institute
[3]Maunakea Spectroscopic Explorer
[4]Canada France Hawaii Telescope
[5]Texas A&M University
[6]Laboratoire d'Astrophysique de Marseille

MSE (Maunakea Spectroscopic Explorer)는 11.25m 구경의 망원경과 최대 4,000 개의 천체를 한 번에 관측할 수 있는 분광기를 통해 다천체 분광학 연구를 이끌 차세대 관측기기이다. 경희대학교는 망원경에 장착되는 다천체 분광기의 성능 요구사항을 바탕으로 노출 시간 소프트웨어 ETC (Exposure Time Calculator)를 개발하고 있다. ETC는 대기에 의한 연속선 소광, 방출선과 흡수선, 망원경 및 광학 기기의 투과율, 검출기의 암전류와 읽기 잡음을 바탕으로 신호 대 잡음비 S/N (Signal to Noise)을 도출하여 천체를 분광 관측하기 위한 적절한 노출 시간을 계산한다. MSE-ETC는 저분산 LR (Low Resolution, R=3,000), 중분산 MR (Moderate Resolution, R =6,000) 및 고분산 HR (High Resolution, R=40,000)의 관측 모드로 가시광선과 근적외선 영역의 S/N과 파장, 그리고 S/N과 AB등급 간의 상관관계를 보여준다. 본 포스터에서는 개발 중인 MSE-ETC 프로그램의 구조와 작동 알고리즘 및 사용 예를 발표한다.

[포 AT-03] Confocal off-axis optical system with freeform mirror, application to Photon Simulator (PhoSim)

Dohoon Kim[1], Sunwoo Lee[2], Jimin Han[3], Woojin Park[4], Soojong Pak[1,3], Jaewon Yoo[4,5], Jongwan Ko[4,5], Dae-Hee Lee[4], Seunghyuk Chang[6], Geon-Hee Kim[7], David Valls-Gabaud[8], and Daewook Kim[9,10]
[1]Department of Astronomy & Space Science, Kyung HeeUniversity, 1732, Deogyeong-daero, Yongin, Republic of Korea
[2]Korea Basic Science Institute, 169-148, Gwahak-ro, Daejeon, Republic Korea
[3]School of Space Research and Institute of Natural Science, Kyung HeeUniversity, 1732, Deogyeong-daero, Yongin, Republic of Korea
[4]Korea Astronomy and Space Science Institute, 776, Daedeok-daero, Daejeon, Republic Korea
[5]University of Science and Technology (UST), Gajeong-ro, Daejeon 34113, Republic Korea
[6]Center for Integrated Smart Sensors, Korea Advanced Institute of Science and Technology (KAIST), 291, Daehak-ro, Daejeon, Republic of Korea
[7]Department of Mechanical and Material Convergence Systems Engineering., Hanbat National University, 125 Dongseo-daero (Deokmyeong-dong), Yuseong-gu, Daejeon, Republic of Korea
[8]LERMA, CNRS, PSL, Observatoirede Paris, 61 Avenue de l'Observatoire, 75014 Paris, France
[9]Department of Astronomy and Steward Observatory, University of Arizona, 933 N. Cherry Ave., Tucson, Arizona 85721, USA
[10]James C. WyantCollege of Optical Sciences, University of Arizona, Tucson, AZ 85721, USA

MESSIER is a science satellite project to observe the Low Surface Brightness (LSB) sky at UV and optical wavelengths. The wide-field, optical system of MESSIER is optimized minimizing optical aberrations through the use of a Linear Astigmatism Free - Three Mirror System (LAF-TMS) combined with freeform mirrors.

One of the key factors in observations of the LSB is the shape and spatial variability of the Point Spread Function (PSF) produced by scatterings and diffraction effects within the optical system and beyond (baffle). To assess the various factors affecting the PSF in this design, we use PhoSim, the Photon simulator, which is a fast photon Monte Carlo code designed to include all these effects, and also atmospheric effects (for ground-based telescopes) and phenomena occurring inside of the sensor. PhoSim provides very realistic simulations results and is suitable for simulations of very weak signals.

Before the application to the MESSIER optics system, PhoSim had not been validated for confocal off-axis reflective optics (LAF-TMS). As a verification study for the LAF-TMS design, we apply Phosim sequentially.

First, we use a single parabolic mirror system and compare the PSF results of the central field

with the results from Zemax, CODE V, and the theoretical Airy pattern. We then test a confocal off-axis Cassegrain system and check PhoSim through cross-validation with CODE V.

At the same time, we describe the shapes of the freeform mirrors with XY and Zernike polynomials. Finally, we will analyze the LAF-TMS design for the MESSIER optical system.

[포 AT-04] Standard Calibration for Broadband and Narrowband Filters of KHAO 0.4 m Telescope

Hojae Ahn[1], Inhwan Jeong[2], Gregory S.H. Paek[3], Sumin Lee[2], Changgon Kim[1], Soojong Pak[1,2], Hyunjin Shim[4], Myungshin Im[3]
[1]School of Space Research, Kyung Hee Univeristy, [2]Department of Space Science, Kyung Hee University, [3]SNU Astronomy Research Center, Department of Physics and Astronomy, Seoul National University, [4]Department of Earth Science Education, Kyungpook University

Maemi Dual Field Telescope System (MDFTS) is a dual telescope system located at Kyung Hee University. The system consists of 0.4 m telescope and 0.1 m telescope for wide-field observation. The 0.4 m telescope provides photometric observation which covers a field of view of 21'×16'. It has been used for various purposes with Johnson-Cousins UBVRI broadband filter system, e.g., SomangNet and Intensive Monitoring Survey of Nearby Galaxies. In this poster, we present the standard calibration result for our broadband filter system. Also, we suggest a new usage of the KHAO 0.4m telescope which is narrowband photometry by demonstrating the standard calibration of H-alpha filter. For flux calibration, not only R filter but also V filter is used for compensating the central wavelength discrepancy between R filter and H-alpha filter.

[포 AT-05] Characterization of the performance of the next-generation controller for the BOES CCD

Su-Hwan Park[1,2], Young Sam Yu[2], Hyun-Il Sung[2], Yoon-Ho Park[2], Sang-Min Lee[2], Seung-Cheol Bang[2], Moo-Young Chun[2], Hyeon-Cheol Seong[2], Minjin Kim[1]
[1]Department of Astronomy and Atmospheric Sciences, Kyungpook National University, [2]Korea Astronomy and Space Science Institute

We present the characterization of the performance of the next-generation controller (SDSU Gen III) for BOAO Echelle Spectrograph CCD (BOES CCD) at the Bohyunsan Optical Astronomy Observatory. The current controller (SDSU Gen II) of the BOES CCD will be upgraded to SDSU Gen III to provide a more stabilized operation. To assess the performance of the new controller (e.g., conversion gain, full well capacity, S/N), we obtain various types of calibration images (e.g., bias, flat, science images of standard stars). Based on those datasets, we find that the overall performance of the new controller is somewhat comparable to that of the old controller if the slow mode is adopted for the readout. This may demonstrate that the new controller can be successfully substituted for the old controller without a substantial loss of performance. However, further analysis with a large dataset obtained in various observational conditions is necessary to confirm our results.

[포 AT-06] Development Plan for the First GMT ASM Reference Body

Ho-Soon Yang[1] ,Chang-Jin Oh[2] , Roberto Biasi [3], Daniele Gallieni [3]
[1]Korea Research Institute of Standards and Science, [2]University of Arizona in USA, [3]AdOptica in Italy

GMT secondary mirror system consists of 7 segmented adaptive mirrors. Each segment consists of a thin shell mirror, actuators and a reference body. The thin shell has a few millimeters of thickness so that it can be easily bent by push and pull force of actuators to compensate the wavefront disturbance of light due to air turbulence. The one end of actuator is supported by the reference body and the other end is adapted to this thin shell. One of critical role of the reference body is to provide the reference surface for the thin shell actuators. Therefore, the reference body is one of key components to succeed in development of GMT ASM. Recently, Korea Research Institute of Standards and Science (KRISS) and University of Arizona (UA) has signed a contract that they will cooperate to develop the first set of off-axis reference body for GMT ASM. This project started August 2021 and will be finished in Dec. 2022.

The reference body has total 675 holes to accommodate actuators and 144 pockets for lightweighting. The rear surface has a curved rib shape with radius of curvature of 4387 mm with offset of 128.32mm. Since this reference body is placed just above the thin shell so that the front surface shape needs to be close to that of thin shell. The front surface has a concave off-axis asphere, of which radius of curvature is 4165.99 mm and off-axis distance is about 1088 mm. The material is Zerodur CTE class 1 (CTE=0.05 ppm/oC)

from SCHOTT. All the actuator holes and pockets are machined normal to the front surface. It is a very complex challenging optical elements that involves sophisticated machining process as well as accurate metrology. After finishing the fabrication of reference body in KRISS, it will be shipped to UA for final touches and finally sent to Adoptica in Italy, in early 2023. This paper presets the development plan for the GMT ASM Reference Body and relevant fabrication and metrology plans.

[포 AT-07] Space Telescope Pre-study of KASI for the Next Decades (2030년대 우주망원경 운영을 대비한 한국천문연구원의 우주망원경 사전 연구)

Bongkon Moon(문봉곤)[1,2], Dae-Hee Lee(이대희)[1], Young-Jun Choi(최영준)[1], Wonyong Han(한원용)[1], Ukwon Nam(남욱원)[1], Youngsik Park(박영식)[1], Won-Kee Park(박원기)[1], Duk-hang Lee(이덕행)[1], Woojin Kim(김우진)[1], Jeong-Yeol Han(한정열)[2], Seonghwan Choi(최성환)[2], Jihun Kim(김지헌)[2], Jongwan Ko(고종완)[3], Il-joong Kim(김일중)[1], Hong-Kyu Moon(문홍규)[1]
[1]Space Science Division, Astronomy and Space Science Institute(한국천문연구원 우주과학본부), [2]Technology Center for Astronomy and Space Science, Korea Astronomy and Space Science Institute(한국천문연구원 천문우주기술센터), [3]Optical Astronomy Division, Korea Astronomy and Space Science Institute(한국천문연구원 광학천문본부)

한국천문연구원은 천문우주분야의 과학임무 탑재체 개발을 주도적으로 수행해오고 있다. 과학기술위성1호 주탑재체 원자외선영상분광기 FIMS 개발, 과학기술위성3호 주탑재체 다목적적외선영상시스템 MIRIS 개발, 차세대소형위성1호 주탑재체 근적외선영상분광기 NISS 개발을 수행하였고, 현재는 NASA와 국제협력으로 SPHEREx 우주망원경을 개발하고 있다.

이러한 개발 과정을 거치면서 주경 20cm 이하의 소형 탑재체 과학임무 한계와 더불어 연구 현장에서 더 큰 우주망원경의 수요가 제기되었고, 현재의 국가우주개발 중장기계획에도 2030년대 한국형 우주망원경을 포함하게 되었다. 이러한 일정에 발맞추어 한국천문연구원은 2030년대 한국형 우주망원경 독자 운영을 대비하기 위해서 2020년 1월부터 주요 사업으로 한국형 우주망원경 개발을 위한 기획연구를 시작하였다. 이 기획연구는 2021년 말까지 2년 동안 수행하고 있으며, 이 기획연구를 통해서 학계의 과학임무 요구사항을 종합 수렴하였고, 관련 컨설팅 업체와 협업하여 사전 기획연구 활동들을 수행하였으며, 향후 우주망원경 개발에 대한 전략을 제안하고 보고서를 마무리하는 단계에 와 있다. 이 발표에서는 이러한 기획연구의 세부 활동을 공유하고 보고하고자 한다.

[포 AT-08] Development Plan of Package-type Instruments for Next-Generation Space Weather Observation Network

Seonghwan Choi, Young-Sil Kwak, Wookyoung Lee, and KASI Space Weather Team
Korea Astronomy and Space Science Institute

Starting with the observation of sunspots in 1987, Korea Astronomy and Space Science Institute (KASI) has developed and installed various ground-based instruments for space weather research in Korea. Recently, SNIPE and CODEX are also being developed as space-based instruments. Expansion of the observation area and simultaneous observation have become important in the study of space weather. We have started Next-Generation Space Weather Observation Network Project this year. In order to establish a solar observation network, we planned to develop the Next Solar Telescope (NxST) which is a solar imaging spectrograph, and to install three NxST in the northern hemisphere. And we also planned to develop the Thermosphere-Ionosphere-Mesosphere Observation System (TIMOS), Global Navigation Satellite System (GNSS), and Geomagnetic packages, and install them in about ten sites over the world, for the purpose of establishing a global observation network for the near-earth space weather. We can take simultaneously observed space weather data in the global area, and are expecting it will play an important role in the international community for space weather research. We also have a strategy to secure observational technologies necessary for big space missions in the future, through this project.

태양/태양계

[포 SS-01] Measurement of Radiative Loss from the Multi-layer Spectral Inversion of the Ha line and Ca II 8542 line taken by the FISS

Soo Sang Kang, Jongchul Chae
Seoul National University

Measuring radiative loss from the solar chromospheric lines like Ha line, Ca II 8542 line helps to infer the exact amount of non-thermal heating in the solar atmosphere. By courtesy of the multi-layer spectral inversion, it is able to determine the radiative loss in the upper and lower chromosphere. Consequently, we found that the radiative loss is around 10 kW/m^2, which is consistent with previous studies. Comparing the radiative loss at the upper and lower chromosphere, the loss at the lower chromosphere

is larger than that of upper chromosphere and tends to spread all over the field of view while the loss in the upper chromosphere tends to be localized. We hope to find a hint for specific non-thermal heating process to explain the chromospheric radiative loss.

[포 SS-02] Optical telescope with spectro-polarimetric camera on the moon

Ilhoon KIM[1], Sukbum HONG[2], Joohyun KIM[3], Haingja Seo[4], Jeong hyun Kim[1], Hwajin Choi[1,5]
[1]SLLAB Inc.
[2]Korean Minjok Leadership Academy
[3]Korea Aerospace Research Institute
[4]HANCOM inSPACE
[5]Department of Astronomy, Space Science and Geology, Chungnam National University

A Lunar observatory not only provides ideas and experiences for space settlements from the Moon to Mars, but also puts the telescope in an optimal position to compete with space telescopes. Earth observation on the Moon's surface has the advantage of no atmospheric scattering or light pollution and is a stable fuel-free observation platform, allowing all longitude and latitude of the Earth to be observed for a month. Observing the entire globe with a single observation instrument, which has never been attempted before, and calculating the global albedo will significantly help predict the weather and climate change. Spectropolarimetric observations can reveal the physical and chemical properties of the Earth's atmosphere, track the global distribution and migration path of aerosols and air pollutants, and can also help detect very small space debris of which the risk has increased recently. In addition, the zodiacal light, which is difficult to observe from Earth, is very easy to observe from the lunar observatory, so it will be an opportunity to reveal the origin of the solar system and take a step closer to understanding the exoplanet system. In conclusion, building and developing a lunar observatory will be a groundbreaking study to become the world's leader that we have never tried before as a first step in expanding human experience and intelligence.

[포 SS-03] Spectroscopic Detection of Alfvénic Waves in Chromospheric Mottles of a Solar Quiet Region

Hannah Kwak, Jongchul Chae
Astronomy Program, Department of Physics & Astronomy, Seoul National University

We present high resolution spectroscopic observations of transverse magnetohydrodynamic (MHD) waves in mottles located near the solar disk center. Different from previous studies that used transversal displacements of the mottles in the imaging data, we investigated the line-of-sight (LOS) velocity oscillations of the mottles in the spectral data. The observations were carried out by using the Fast Imaging Solar Spectrograph of the 1.6 meter Goode Solar Telescope of Big Bear Solar Observatory. Utilizing the spectral data of the Hα and Ca II 8542 Å lines, we measure the LOS velocity of a quiet region including the mottles and rosettes that correspond to the footpoints of the mottles. Our major findings are as follows: (1) Alfvénic waves are pervasive in the mottles. (2) The dominant period of the waves is 2 to 4 minutes. (3) From the time-distance maps of the three-minute filtered LOS velocity constructed along the mottles, it is revealed that the transverse waves in the mottles are closely related to the longitudinal waves in the rosettes. Our findings support the notion that Alfvénic waves can be generated by mode conversion of the slow magnetoacoustic waves as was shown in sunspot regions by Chae et al. (2021).

[포 SS-04] CODEX Filter Configuration

Su-Chan Bong[1], Heesu Yang[1], Jihun Kim[1], Jae-Ok Lee[1], Yeon-Han Kim[1], Kyuhyoun Cho[2], Nelson L. Reginald[3,4], Qian Gong[3], Jason G. Budinoff[3,5], Jeffrey S. Newmark[3]
[1]Korea Astronomy and Space Scinece Institute, Korea, [2]Seoul National University, Korea, [3]NASA Goddard Space Flight Center, USA, [4]The Catholic University of America, USA, [5]ADNET Systems, USA

Coronal Diagnostic Experiment (CODEX) is a diagnostic coronagraph developed by the Korea Astronomy and Space Science Institute and the NASA Goddard Space Flight Center (GSFC) to be deployed in 2023 on the International Space Station (ISS). It is designed to obtain simultaneous measurements of electron density, temperature, and velocity in the 2.5 – 10 solar radius range using multiple filters. The filters are mounted in two filter wheel assemblies (FWAs), which have five filter positions each. One position of each FWA is occupied by windows, and remaining eight positions are occupied by three bandpass filters for temperature, two bandpass filters for velocity, one Ca II H filter for F-corona, one broadband filter for fast imaging and density, and one neutral density (ND) filter for direct Sun viewing and safety.

[포 SS-05] Next Generation Solar Telescope Global Network: Three Eyes for the Studies

on the Space Weather Prediction and the Solar Chromospheric Activities (차세대 태양영상분광망원경 글로벌 네트워크: 세 개의 눈을 통한 우주환경예보과 채층활동 연구)

Heesu Yang, Seounghwan Choi, Jihun Kim, Sujin Kim, Eun-Kyung Lim, Juhyung Kang, Dong-Uk Song, Ji-Hye Baek, Jongyeob Park
Korea Astronomy and Space Science Institute

NxST는 현재 천문연에서 개발중인 30cm 구경의 태양망원경으로 태양 채층의 모습을 약 1각초의 적정한 영상해상도로 고분광분해능의 채층선 스펙트럼 자료를 고속으로 얻어낼 수 있다. NxST는 미국과 유럽, 그리고 국내 1대를 건설하여 전지구적으로 연속적인 데이터를 획득할 수 있다. NxST의 관측자료는 1) 우주환경예보의 최초이며 유일인자인 태양을 실시간으로 감시할 수 있고 2) 태양 채층의 파동과 관련된 연구를 수행하는데 활용될 수 있다. 본 발표에서는 NxST의 연구주제들을 살펴보고 이로부터 도출된 시스템의 개념 설계를 제시한다.

[포 SS-06] Simple modeling to explore temperatures, heated temperature, and Kappa values of a current sheet observation

Jin-Yi Lee[1], John C. Raymond[2], Katharine K. Reeves[2], Chengcai Shen[2], Stephen Kahler[3], Yong-Jae Moon[1], and Yeon-Han Kim[4,5]
[1]*Kyung Hee University*
[2]*The Center for Astrophysics | Harvard & Smithsonian*
[3]*Air Force Research Laboratory*
[4]*Korea Astronomy & Space Science Institute*
[5]*University of Science and Technology*

We explore the range of possibilities of temperatures, heated temperature, and Kappa values of a current sheet observation on 2017 September 10. First, we construct a grid model with rapid heating (T_{heat}) and various Kappa (κ) values. We assume a simple density model and use adiabatic cooling to set the temperature during expansion. Next, we calculate the ion fractions using a time-dependent ionization model with adiabatic cooling and various Kappa values. The calculated ion fractions are used to simulate the DNs of the Atmospheric Imaging Assembly on board the Solar Dynamic Observatory. Then, we explore the possible range of the temperatures and Kappa values, comparing the simulated images with the observations. Finally, we discuss the range of the heated temperature and Kappa values and whether the result of this study suggests continuous heating of the current sheet plasma during the expansion.

[포 SS-07] Development of a diagnostic coronagraph on the ISS: CODEX progress report

Yeon-Han Kim[1], Seonghwan Choi[1], Su-Chan Bong[1], Kyungsuk Cho[1,2], Jeffrey Newmark[3], Nat. Gopalswamy[3], KASI-NASA Coronagraph Team
[1]*Korea Astronomy and Space Science Institute, Korea*
[2]*University of Science and Technology, Korea*
[3]*NASA Goddard Space Flight Center, USA*

The Korea Astronomy and Space Science Institute (KASI) has been developing a diagnostic coronagraph to be deployed in 2023 on the International Space Station (ISS) in collaboration with the NASA Goddard Space Flight Center (GSFC). The mission is known as “Coronal Diagnostic Experiment (CODEX)”, which is designed to obtain simultaneous measurements of the electron density, temperature, and velocity using multiple filters in the 2.5-10 Rs range. The coronagraph will be installed and operated on the ISS to understand the physical conditions in the solar wind acceleration region, and to enable and validate the next generation space weather models. In this presentation, we will introduce recent progress and future plan.

[포 SS-08] Subsurface structure of a sunspot inferred from umbral flashes

Kyuhyoun Cho
Seoul National University

Sunspots' subsurface structure is an important subject to explain their stability and energy transport. Previous studies suggested two models for the subsurface structure of sunspots: monolithic model and cluster model. However, it is not revealed which model is more plausible so far. We obtain clues about the subsurface structure of sunspots by analyzing the motion of umbral flashes observed by the IRIS Mg II 2796 Å slit-jaw images (SJI). The umbral flashes are believed as shock phenomena developed from upward propagating slow magnetohydrodynamic (MHD) waves. If the MHD waves are generated by convective motion below sunspots, the apparent origin of the umbral flashes known as oscillation center will indicate the horizontal position of convection cells. Thus, the distribution of the oscillation centers is useful to investigate the subsurface structure of sunspots. We analyze the spatial distribution of oscillation centers in the merged sunspot. As a result, we found that the oscillation centers distributed over the whole umbra regardless of the convergent interface between two merged sunspots. It implies that the subsurface structure of the sunspot is not much different from the convergent interface, and

supports that many field-free gaps may exist below the umbra as the cluster model expected. For more concrete results, we should confirm that the oscillation centers determined by the umbral flashes accurately reflect the position of wave sources.

항성,항성계/외계행성

[포 SA-01] Current Status of Intensive Monitoring Survey of Nearby Galaxies and Core-Collapse Supernovae Observational Research

Sophia Kim[1], Myungshin Im[1], Changsu Choi[2], Gu Im[1], Gregory S. Paek[1], IMSNG Team
[1]Seoul National University (SNU), [2]Korean Astronomy & Space Science Institute (KASI)

Intensive Monitoring Survey of Nearby Galaxies (IMSNG) is a program monitoring nearby galaxies with a high cadence within a day. The main goal of the project is to constrain the SNe explosion mechanism and properties of their progenitors by catching the early lights from the shock-heated cooling emission. The observation campaign began in 2014 with two 1-m class telescopes in the northern hemisphere. Now more than ten telescopes are monitoring galaxies with 60 IMSNG targets, which have a high probability of supernova explosion every night all around the world. Since the project started, the following observations have been carried out on 14 SNe Ia(including -pec), 27 core-collapse supernovae (CCSNe), and around 40 transients in other types.

In this poster, we present the current status of IMSNG SNe data first and then focus more on the CCSNe. CCSNe are the explosion of massive stars, more massive than eight times of the Sun. They have been studied for more than a half decades but still have key questions to be solved, such as distinct types, the characteristics driving their diversity, and so on. Here, we show our ongoing studies of CCSNe in IMSNG, focusing on their usefulness as distance indicators and properties of early light curves.

[포 SA-02] Identifying clusters of red supergiants in Galactic plane using 2MASS and GAIA G band colors

Jae-Joon Lee(이재준), Sang Hyun Chun(천상현)
Korea Astronomy and Space science Institute

Galactic young massive clusters are the ideal laboratories to study massive stellar evolution. Unfortunately, such objects are rare. Of particular interest are so-called Red Supergiant Clusters (RSGCs) that are currently only found toward the Scutum-Crux Galactic arm. Confirming their nature as RSGC is often not straight-fortward as distinguishing RSGs from AGB stars is still difficult even with high spectral resolution spectra. Here we report that broad band colors using 2MASS JHK and GAIA G band data can be useful in reducing the AGB contamination, thus providing selection criteria that effectively reveal the known RSGCs with negligible false positives. On the other hand, we suggest that RSGC4, one of the proposed RSGC candidates, may not be a cluster of RSGs as their colors are not compatible with our selection criteria. We discuss the nature of these stars together with our IGRINS spectroscopic observations. We also employ the same selection criteria to search for RSGC candidates in other parts of the plane, resulting in no prominent candidates.

[포 SA-03] Pushing precision and accuracy of RR Lyrae variables as distance indicators

Anupam Bhardwaj and Soung-Chul Yang
Korea Astronomy and Space Science Institute

RR Lyrae variables are excellent distance indicators thanks to their visual magnitude-metallicity relation and well-defined Period-Luminosity Relations (PLRs) at infrared wavelengths. These population II variables together with the tip of the red giant branch provide primary calibration for the first-rung of the population II distance ladder. We will present new empirical calibration of RR Lyrae PLRs at near-infrared wavelengths using our data from the ongoing CFHT-WIRCam RR Lyrae program.
We will discuss the systematic uncertainties involved in the calibration of these relations based on the latest Gaia EDR3 parallaxes and the implication for the cosmic distance scale.

[포 SA-04] The Kinematic Properties of Young Stars in NGC 281: its implication on star formation process (NGC 281의 젊은 별들의 운동학적 특성)

Seulgi Kim[1], Beomdu Lim[2]
[1]Sejong University, [2]Kyung Hee University

Stellar kinematics is a useful tool to understand the formation and evolution of young stellar

systems. Here, we present a kinematic study of the HII region, NGC 821, using the Gaia Early Data Release 3. NGC 281 contains the open cluster IC 1590. This cluster has a core and a low-stellar density halo. We detect a pattern of cluster expansion from the Gaia proper motion vectors. Most stars radially escaping from the cluster are distributed in the halo. We measure the 1-dimensional velocity dispersion of stars in the core. The velocity dispersion (1 km/s) is comparable to the expected virial velocity dispersion of this cluster, and therefore the core is at a virial state. The core has an initial mass function shallower than that of the halo, which is indicative of mass segregation. However, there is no significant correlation between stellar masses and tangential velocities. This result suggests that the mass segregation has a primordial origin. On the other hand, it has been believed that the formation of young stars in NGC 281 West was triggered by feedback from massive stars in IC 1590. We investigate the ages of stars in the two regions, but the age difference between the two regions is not comparable to the timescale of the passage of an ionization front. Also, the proper motion vectors of the NGC 281 West stars relative to IC 1590 do not show any systematic receding motion from the cluster. Our results suggest that stars in NGC 281 West might have been formed spontaneously. In conclusion, the formation of NGC 281 can be understood in the context of hierarchical star formation model.

[포 SA-05] STaRS Gen 2: Sejong Radiative Transfer through Raman and Rayleigh Scattering in Dusty Medium

Seok-Jun Chang[1], Hee-Won Lee[1], Kwang-Il Seon[2,3]
[1]Department of Physics and Astronomy, [2]Sejong University, Korea Astronomy and Space Science Institute, [3]Astronomy and Space Science Major, University of Science and Technology

Emission features formed through Raman scattering with atomic hydrogen provide unique and crucial information to probe the distribution and kinematics of a thick neutral region illuminated by a strong far-ultraviolet radiation source. We introduce a new 3-dimensional Monte-Carlo code to describe the radiative transfer of line photons subject to Raman and Rayleigh scattering with atomic hydrogen. In our Sejong Radiative Transfer through Raman and Rayleigh Scattering (STaRS) code, the position, direction, wavelength, and polarization of each photon is traced until escape. The thick neutral scattering region is divided into multiple cells. Each cell is characterized by its velocity and density, which ensures flexibility of the code in analyzing Raman-scattered features formed in a neutral region with complicated kinematics and density distribution. We are continuously developing STaRS to adopt the absorption and scattering effect by dust. This presentation introduces STaRS and its current state and study.