

Activity Report 2009



2010. 5

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May, 2010

Preface

The Korea Astronomy and Space Science Institute has been a hub organization for Korean astronomical research throughout the last half-century. KASI is now making great strides to reach the level of a world class institute. To do this, KASI is making various efforts towards the achievement of worldwide excellence by exploiting international scientific resources.

Against this background, the Future Strategy Team submits this report for External Review 2010 on behalf of KASI. In order to provide reviewers with information on KASI activities, the report outlines the various aspects of KASI: some general information, research performance, public outreach, and managerial issues. In the appendix, Curriculum Vitae of key scientists help reviewers to comprehensively understand the research performance of KASI.

Regarding the contents of this report, no prejudice and no intentional false statements are provided here. If you have any queries and need further information, please do not hesitate to contact us.

3rd May, 2010



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1. General Information

1. General Information

1.1 Mission, Functions, and History

1.1.1 Mission, and Functions

Mission, and Mission Statement

The Korea Astronomy and Space Science Institute (KASI) was established to carry out academic research and comprehensive technology development for the improvement of astronomy and space science, and to disseminate the consequent accomplishments on the basis of Article 8-1 of the Act on the Establishment, Operation and Fostering of Government-Invested Research Institutions.

In addition, in the process of long-term planning in 2006, KASI developed its own mission statement based on its legal mission from the government. The mission statement, “*We seek scientific answers to the ultimate questions of the universe*”, was absolutely agreed by all KASI staff and was subsequently defined in detail.

- We: Active and passionate participation of all staff
- Universe: Long-term and vast space including the Earth, moon, sun, stars and galaxy
- Ultimate questions: The origin of the universe and the relationship between the universe and mankind
- Scientific: Astronomy and space science which includes rational/ technological approaches and the tools, methods and technologies used in astronomy
- Seek scientific answers: To discover hidden theories, to study the nature of the universe, to distribute the accomplishments of KASI and to contribute to the nation and to mankind

Functions

The functions of KASI were categorized into five, as follows.

- To publish the Korean Astronomical Almanac and Standard Time
- To deepen the understanding of the universe and human beings through wide and de-

tailed telescopic observations and theoretical analysis

- To discover novel astronomical phenomena and expand the research areas of space science using newly developed astronomical instruments
- To promote international research activities by collaborating with foreign astronomers
- To distribute astronomical information for the the development of a nationwide science culture

1.1.2 History

Year	Contents
1974	Korea National Astronomical Observatory (KNAO) founded.
1978	Sobaeksan Optical Astronomy Observatory (SOAO) built at Mt.Sobaek.
1985	Taeduk Radio Astronomy Observatory (TRAO) built at Daejeon.
1986	Institute of SpaceScience and Astronomy (ISSA) reformed from KNAO.
1991	ISSA changed to Korea Astronomy Observatory (KAO).
1992	Global Positioning System (GPS) station built at KAO.
1996	Bohyunsan Optical Astronomy Observatory (BOAO) built at Mt.Bohyun.
1997	The first instrument for space astronomy (x-ray detector) was tested by mounting it on a two-stage Korean sounding rocket.
2002	Solar Imaging Spectrograph Telescope built at KAO. YSTAR-NEOPAT (Yonsei Survey Telescopes for Astronomical Research - Near Earth Object Patrol) South Africa Station built at Sutherland.
2003	Mt. Lemmon Optical Astronomy Observatory built at Mt.Lemmon,ArizonaintheUnitedStates. The first Korean space telescope, FIMS (Far-ultraviolet IMaging Spectrograph) launched on board STSAT-1.
2004	KAO was renamed Korea Astronomy and Space Science Institute (KASI). Korean VLBI Network construction initiated.
2005	YSTAR-NEOPAT Australia station built at Siding Spring. International Center for Astrophysics established at KASI.
2006	Space Geodesy Division established at KASI. International GNSSServiceGlobalDataCenter started operating at KASI.
2007	Space Weather Monitoring Lab opened at KASI.
2008	Construction of Korea VLBI Network (KVN) completed.
2009	Data Center for Astronomical Almanac was officially appointed by the Ministry of Knowledge Economy.

1.2 Organization, Personnel, and Budget

1.2.1 Organization

KASI organizes its research activities under five divisions: the Optical & Infrared Astronomy Division, the Radio Astronomy Division, the Space Science Division, the Technology R&D Division and the International Center for Astrophysics. Previously there were four research divisions, but the manpower involved in technology development and support was recently gathered from these four divisions to form an additional division.

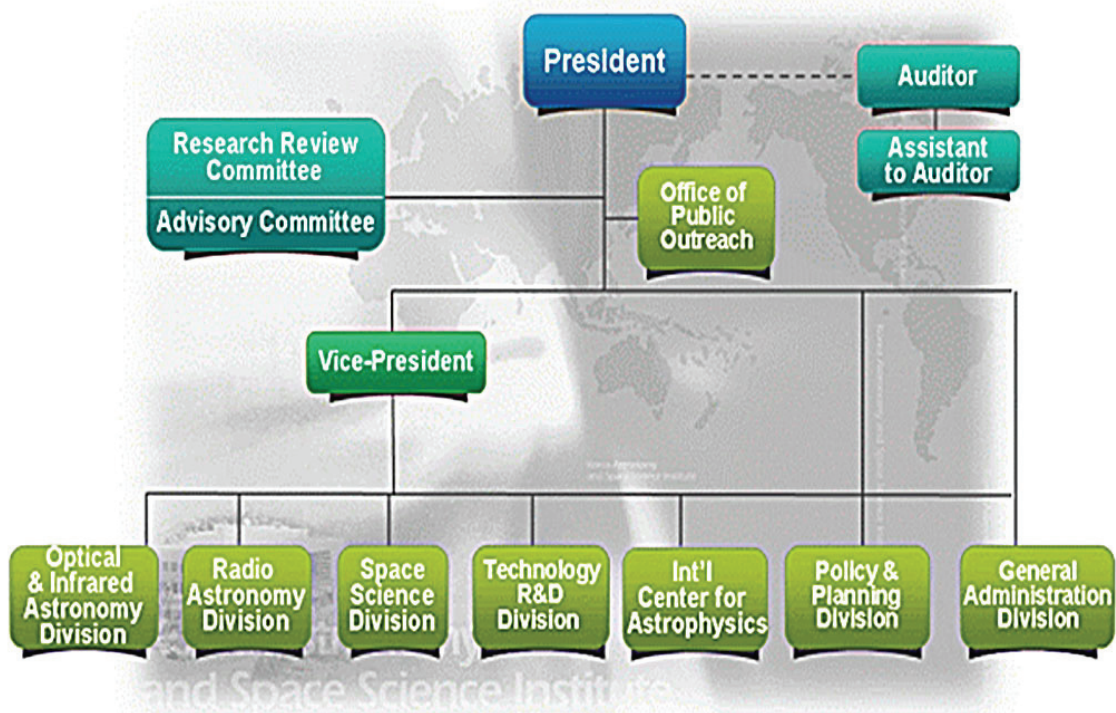


Fig. 1 Organization chart of KASI

1.2.2 Personnel

KASI has 136 regular employees in total, currently including 81 researchers and 27 engineers, and the number of employees has increased over the last five years, as follows:

(Unit: Person, as of April, 2010)

Occupation		2006	2007	2008	2009	2010
Researcher (by Academic Qualification)	Ph.D	62	70	72	73	73
	Non-Ph.D	8	8	7	8	8
Technical Staff	Engineers	20	24	27	27	27
	Technicians	7	7	7	7	7
Administrative Staff	Administrators	17	20	20	20	20
	Clerks	1	1	1	1	1
Sub-total		109	115	130	134	134

The employees for R&D and public outreach are placed in each research division, as follows:

(Unit: Person, as of April, 2010)

Division	No. of Employees (Reg./Temp.)	Regular/Temporary Employees				
		Researcher	Technical Staff	Clerk	Administrator	Temporary
Office of Vice-President	3/2	2/0	0/0	0/0	1/0	0/2
Optical-infrared Astronomy Division	23/20	16/0	5/0	2/0	0/0	0/20
Radio Astronomy Division	18/11	15/0	3/0	0/0	0/0	0/11
Space Science Division	24/26	19/0	5/0	0/0	0/0	0/26
Astronomy Technology R&D Division	17/9	11/0	5/0	0/0	1/0	0/9
International Center for Astrophysics	18/17	17/0	1/0	0/0	0/0	0/17
Public Outreach Office	8/7	0/0	6/0	1/0	1/0	0/7
Total	111/90	77/0	25/0	3/0	2/0	0/90

1.2.3 Budget

The annual budget of KASI for 2010 is KRW 42,063,000,000. A large portion of the KASI research budget comes from the Ministry of Education, Science and Technology.

(Unit: Million KRW)

	2006	2007	2008	2009	2010
Personal Expenses	6,864	7,618	8,633	9,131	9,270
Research Budget	10,760	12,827	13,265	18,125	26,675
Routine Management Expenses	1,300	1,755	1,849	1,757	2,063
Facility Operation Expenses	900	900	1,100	2,600	4,000
Etc.	50	50	50	50	50
Total Budget	19,874	23,150	24,897	31,663	42,063

1.3 Facilities, and Equipment

1.3.1 Domestic Facilities, and Equipment

KASI has a headquarters and some local sites across South Korea, as follows:

- Headquarters and Taeduk Radio Observatory in Daejeon (KASI H.Q. and TRAO): A GPS station and a 14m radio telescope
- Sobaeksan Optical Astronomy Observatory (SOAO) in Danyang: 61cm reflecting telescope
- Bohyunsan Optical Astronomy Observatory in YeongCheon (BOAO): 1.8m reflecting telescope
- Korea VLBI Network (KVN) in Seoul, Ulsan and Jeju: 21m radio telescope in three sets



1.3.2 Overseas Facilities, and Equipments

KASI has three overseas sites which are operated remotely from the headquarters, as follows:

- Mt. Lemmon Optical Astronomy Observatory in Arizona, USA (LOAO): 1m reflecting telescope
- South Africa Station (joint between KASI, Yonsei University and the South African Astronomical Observatory): 60cm wide-field telescope
- Australian Station (joint between KASI, Yonsei University and New South Wales University): 60cm wide-field telescope

KASI is currently carrying out some projects to construct world-class facilities overseas in collaboration with advanced foreign institutions, and is expected to have competitive infrastructure in the near future.

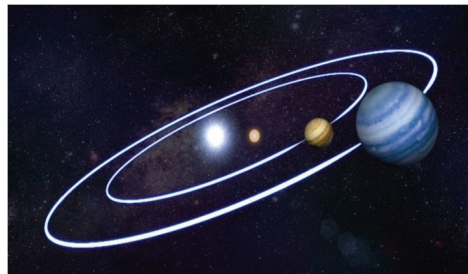


1.4 Research Achievements

1.4.1 Major R&D Highlights

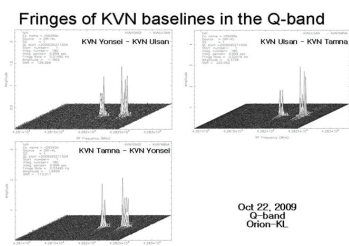
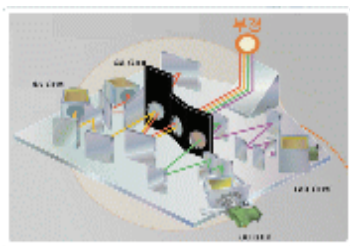
The world's first discovery of an extra-solar planet with two suns

KASI discovered an extra-solar planet with two suns in HW Vir (around 590 light years away, near Virgo) using the analysis method at eclipsing time of eclipsing binary stars for the first time in the history.



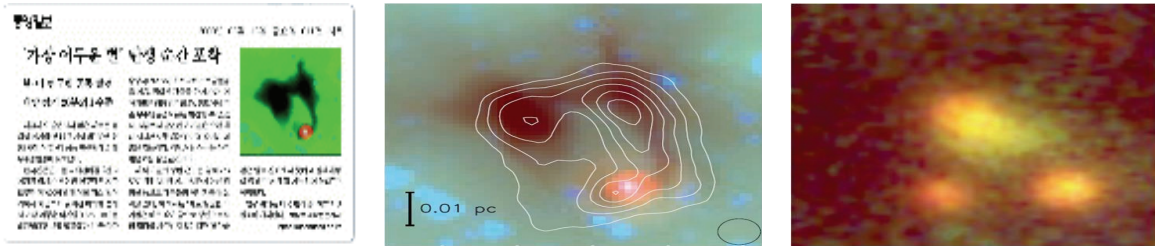
Completion of development of KVN 22 and 43 GHz receivers and their fringe acquisition

KASI developed the 22 and 43 GHz simultaneous observation receiving systems and installed them at KVN 3 sites. It is the first step to establishing the world's first simultaneous observation system in four frequencies for mm wave VLBI observation. Following the development, KASI acquired the fringes of KVN baselines of 22 and 43 GHz.



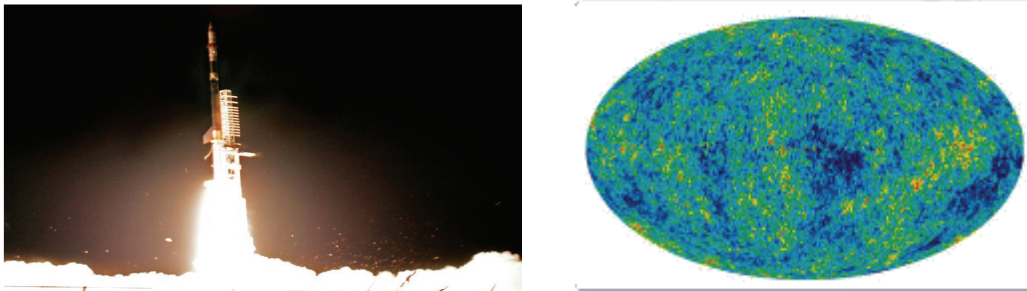
Discovery of the darkest star, which is only 5% of the sun in brightness

A team of researchers led by Dr. Chang-Won Lee of KASI discovered the L328-IRS, the darkest baby star ever known, in a gas mass located 600 light years away. The baby star is only 5% of the sun in brightness.



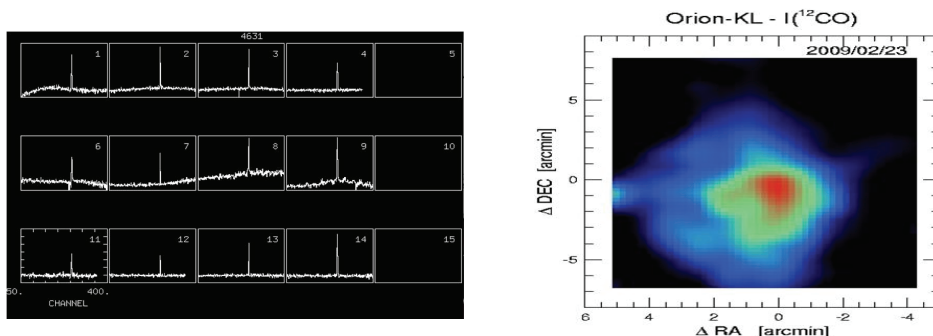
Success in infrared observation of cosmic background radiation

KASI participated in the development of an infrared camera system in collaboration with KBSI, NASA/JPL, Caltech and JAXA/ISAS. The rocket loaded with the infrared camera system successfully observed cosmic background radiation on February 25th, 2009.



Establishment of a multi-beam receiver system in TRA0

KASI finally succeeded in the establishment of a multi-beam receiver in TRA0. As a result, the observation efficiency increased around ten times in case of broadband mapping observation.



□ **Discovery of a Jupiter=Saturn Analog with Gravitational Microlensing**

KASI has discovered two planets that resemble smaller versions of Jupiter and Saturn in a solar system nearly 5,000 light years away. The find suggests that our galaxy hosts many planetary systems like our own.



1.4.2 Publications

KASI has striven to product papers in both quantity and quality. The trends of total and average numbers of papers, which demonstrate the quantitative productivity of KASI, are fluctuating slightly every year; however, the qualitative productivity has increased, judging by the indicator of the SCI journal impact factor in total and average.

Performance Indicator	KASI in General							
	'06		'07		'08		'09	
Total No. of Papers (Domestic/Overseas)	58	87	43	79	51	104	59	89
No. of SCI Papers (Domestic/Overseas)	6	87	1	79	1	101	6	87
SCI Journal Impact Factor (Total/Average)	402.69	4.33	336.23	4.2	473.22	4.64	449.9	4.84
SCI Papers per Researcher	1.45		1.18		1.44		1.25	

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2. Vision, and Strategies

2. Vision, and Strategies

2.1 Vision

2.1.1 Mission, and Vision

In alignment with the mission of KASI, all the goals, directions and strategies have been established and implemented so far. The vision of KASI is: “to be the top-class research institute of astronomy and space science and to lead the era of space science” by 2018. This vision is being achieved through strategic goals, which are managerial goals devised by the president of KASI, including key performance indicators for long-term planning. While planning the sub-strategies and action plans, KASI was able to identify what qualities makes KASI members pursue the KASI mission and vision. These qualities are: inquiring minds, excellency, and customer satisfaction, which have been established as the “core values” of KASI.



Fig. 2 The diagram of relationship between mission, vision, goals, and core values

KASI aims to manifest its vision by 2018, which includes four specific reflections as follows:

By 2018, KASI will be a top-class research institute of astronomy and space science and will lead the era of space science. In particular, KASI will:

- ▷ possess more than three leading research groups of international level.
- ▷ construct and operate state-of-the-art observation instruments and facilities of international competitiveness.
- ▷ be one of the mainstays of space development nationally and contribute to its quality improvement.
- ▷ be the Korean public's favorite national research institute, leading the scientific culture.

The vision also has progress milestones in three steps.

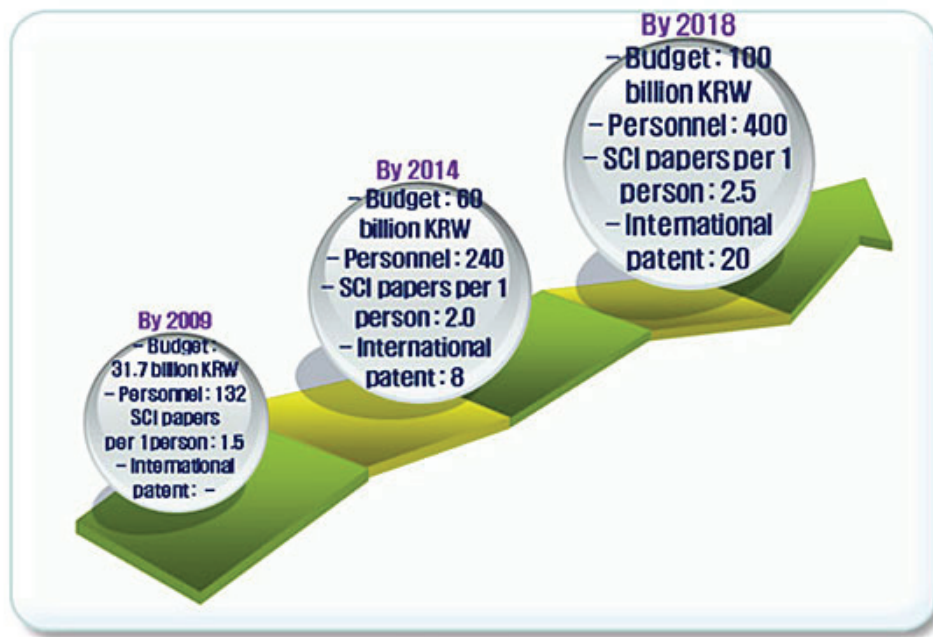


Fig. 3 The three steps of the vision milestone by 2018

2.2 Strategies

2.2.1 Long-range Plan

KASI currently has three major plans under which it works. There are: 1) the Managerial Goals set by a newly proceeding KASI president every three years; 2) the Long-range Plan (Key Research Programs), running for five years and 3) the Long-range Plan (Management and Research), running for ten years. The five-year Long-range Plan stipulates the key research programs, describes the road-maps of these programs, and sets out what KASI will do to support each program in the aspects of budget and manpower.

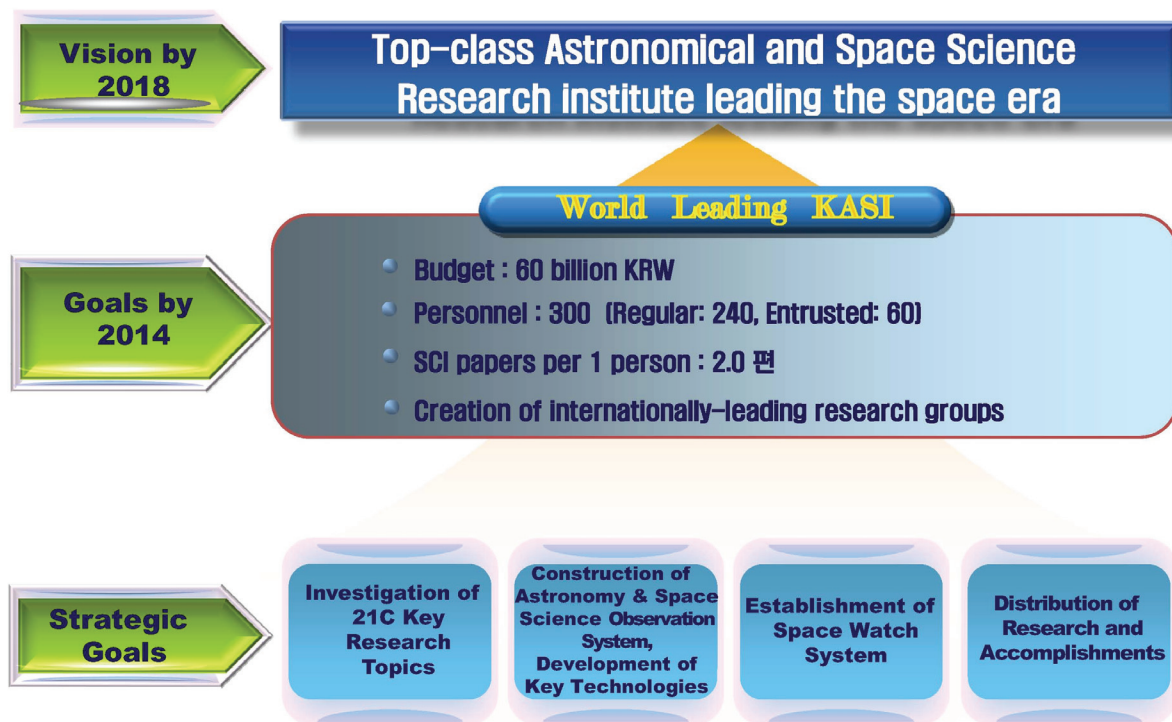


Fig. 4 Vision and strategic goals of five-year Long-range Plan

The ten-year Long-range plan was established based on the BSC (Balanced Score Card) method. The strategies were drawn from four performance indicators (Excellent Achievement, Customer Satisfaction, Strategic Management and Competency Enhancement), which are closely linked and which give feedback to each other.

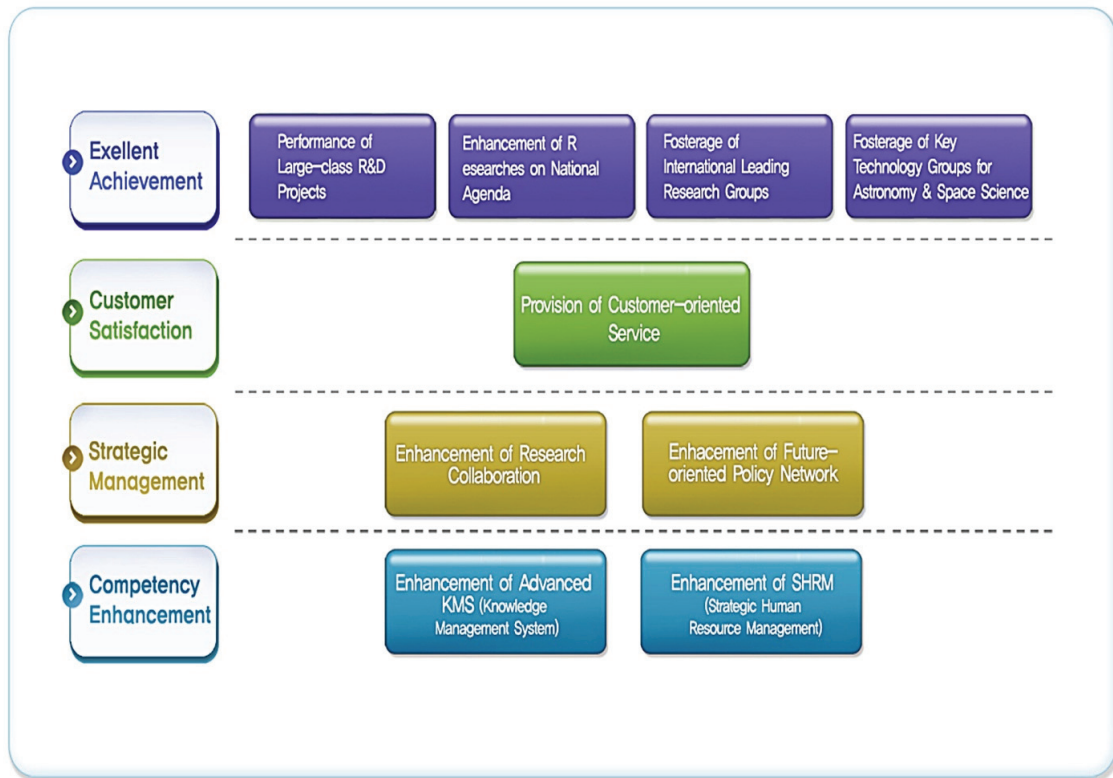


Fig. 5 Performance Indicators and related strategic tasks of the ten-year Long-range Plan

The five-year Long-range Plan on research programs is strategically coordinated with five goals of the ten-year Long-range Plan as follows. All the programs entail the four tasks that belong to excellent R&D achievement (see the above Fig. 5) quantitatively and qualitatively.

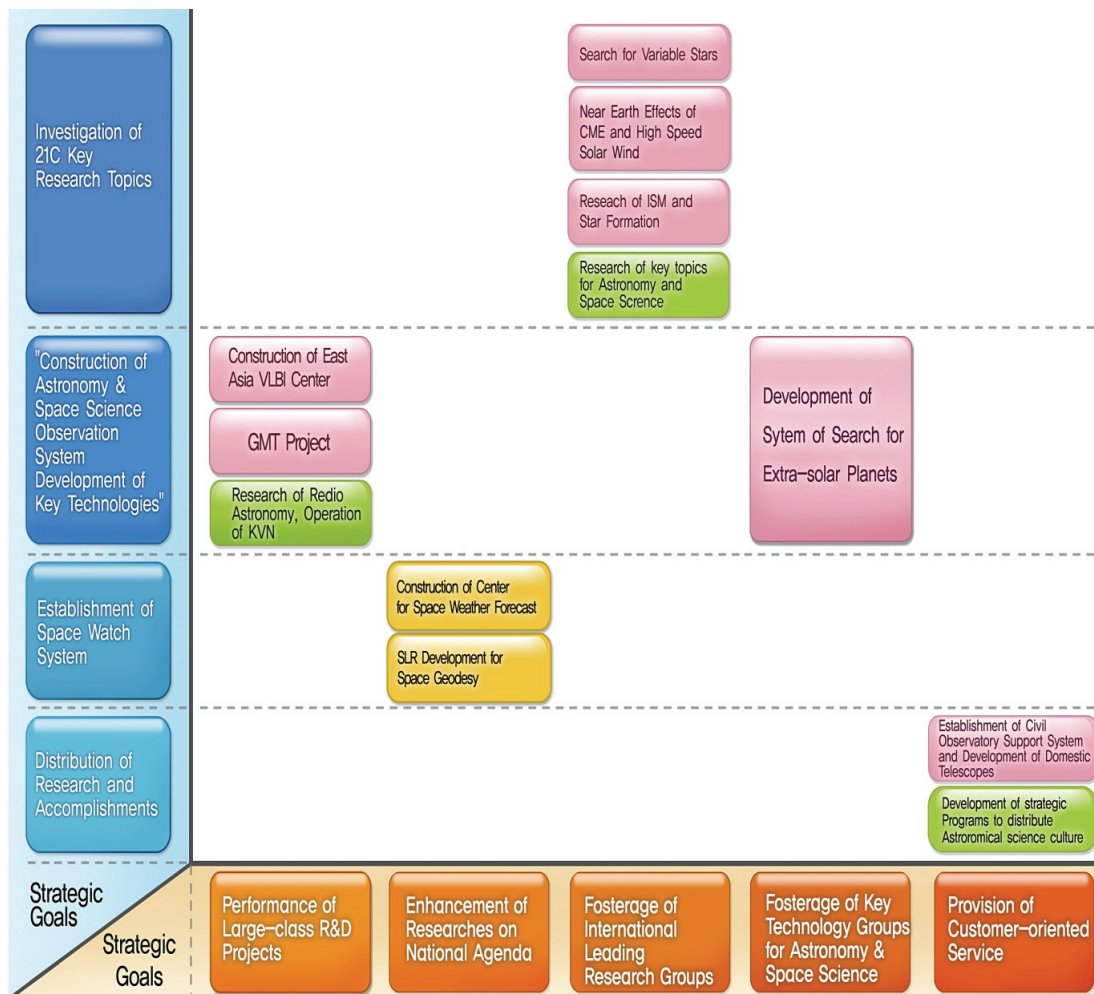


Fig. 6 The Long-range Plan of research programs and the correlation with strategic tasks for ten-year Long-range Plan

Each research program in the five-year Long-range Plan has its own goals and specific action plans, which we call the 'total road-map', throughout the sub-plans. As shown below, by 2014 the total road-map aligns four strategic goals, ten research programs and six long-term goals.

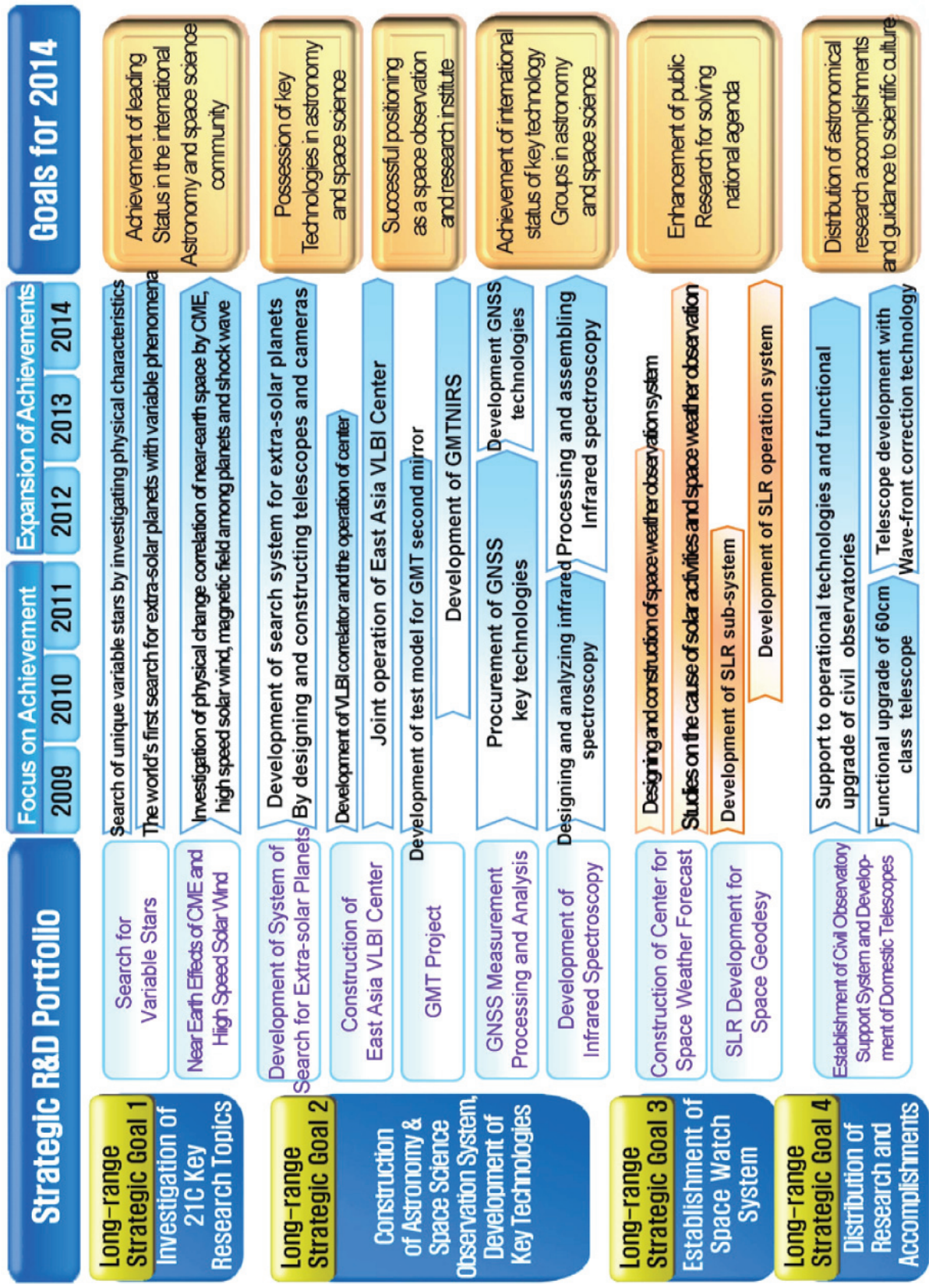


Fig. 7 Total road-map for five-year Long-range Plan

3. Research Fields, and Key Research Areas

3. Research Fields, and Key Research Areas

3.1 Research Fields

3.1.1 Optical Astronomy

Current Research Facilities

After the foundation of the Korean National Astronomical Observatory in 1974, it is said that the modern history of Korean astronomy started with the 61cm Sobaeksan Optical Astronomy Observatory (SOAO) telescope in 1978. Initially this telescope was mostly used for the training of students and for initial astronomical research in Korea. It is still being used for active research, especially in the studies of eclipsing binaries, pulsating stars, and variable stars (<http://soao.kasi.re.kr>).

In 1996, a 1.8m telescope was installed at Bohyunsan Optical Astronomy Observatory (BOAO) located at Mt. Bohyun in the south-eastern part of Korea, which has been used for modern observational research (<http://boao.kasi.re.kr>). This telescope has three major components: (1) CCD camera with a field of view of $11.7' \times 11.7'$ (2048 pixels \times 2048 pixels), which is being replaced by a new 4096 pixels \times 4096 pixels CCD; (2) BOES (BOAO Optical Echelle Spectrograph), which is a fiber-fed spectrograph equipped with iodine cell for precise radial velocity measurement. It can cover an optical wavelength range of 3,600 Å~10,200 Å in one CCD frame of 2048pixels \times 4096 pixels (pixel size of 15 μ m); and (3) KASI near-infrared camera system (InSb 512pixels \times 512pixels; filters are J, H, Ks, L, H2, & H3+) which can cover a near-infrared wavelength band of 1~5 μ m with a field of view of 3.3' \times 3.3. Fig. 8 is a picture of the 1.8m telescope, and Fig. 9 is a sample of the Korean 10,000Won bill, on the back of which the 1.8m telescope is printed.

Another 1m telescope was installed in 2003 at Mt. Lemmon Optical Astronomy Observatory (LOAO), located at Mt. Lemmon near Tucson, Arizona, USA (<http://loao.kasi.re.kr>). The telescope is operated remotely from the main KASI building in Daejeon, Korea via the internet. LOAO has more than 200 clear nights per year. The time difference of 16 hours between Korea and Tucson makes it useful for longer coverage of light curves of variable stars.

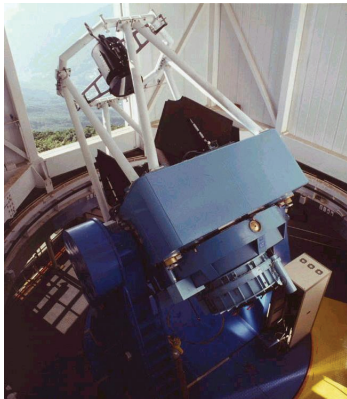


Fig. 8 1.8m telescope in BOAO



Fig. 9 Specimen of the Korean 10,000 Won bill.
The BOAO 1.8m telescope is printed on the back

Ongoing Projects

Two major projects in optical astronomy were started in 2009. These are the Korean Giant Magellan Telescope (K-GMT) project and the Korean Microlensing Telescope Network (KMTNet).

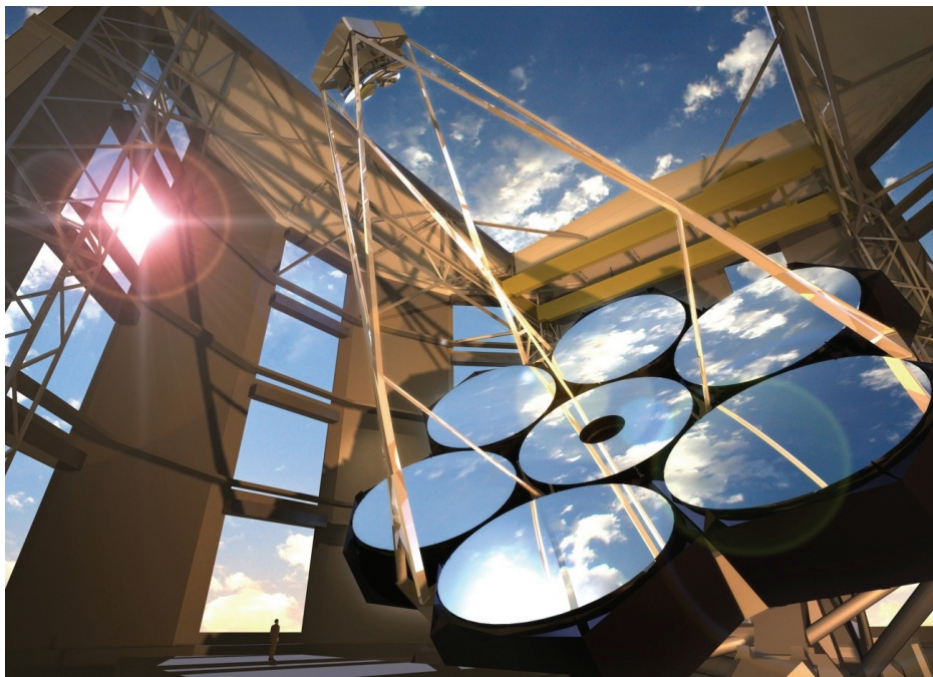


Fig. 10 An artist's drawing of the 25m Giant Magellan Telescope

K-GMT is a ten-year project (2009-2018), participating in the GMT project as a 10% partner, and developing both Korean science programs and Korean technologies related to astro-

nomical telescopes. The GMT is an innovative 25m telescope composed of seven 8.4m-diameter mirrors (one mirror in on-axis and the surrounding six mirrors in off-axis, see Fig. 10), which can produce images ten times sharper than those from the Hubble Space Telescope using adaptive optics techniques. This can be used to probe to far fainter levels than possible with today's largest ground-based telescopes. The GMT will be located at Las Campanas Observatory in the Andes Mountains of Chile and is scheduled to be completed around 2019. GMT is a multi-purpose telescope operating in the visible and infrared wavelength bands of 320nm~25 μ m, and will produce an unobstructed field of view not less than 20' in diameter. In the near future, it will be a crucial tool for investigating many questions at the forefront of astrophysical research such as (1) understanding planet formation outside the solar system, (2) determining the nature of dark matter and dark energy, (3) understanding stellar populations and the origin of the chemical elements, (4) probing the mysterious black holes, (5) understanding the formation of galaxies, and (6) detecting the first light photons and the re-ionization processes of the universe. Current partners of the GMT projects include KASI, Carnegie Institution for Science, Harvard University, the Smithsonian Institution, Texas A&M University, the University of Arizona, the University of Texas at Austin, Australian National University and Astronomy Australia Limited.

KMTNet is also a ten-year project (2009-2018) to build a network of three 2m-class telescopes with a field of view of 2°×2° (with mosaic CCDs having a pixel size of 20K×20K). The telescopes will be installed on the three southern hemisphere continents (Africa, Oceania, and South America), which will give full 24-hour coverage of any celestial object. The goals of the KMTNet are to discover Earth-mass class extra-solar planets from ground-based observation, a huge number of extra-solar planets in a wide mass range, and a huge number of variable stars.

3.1.2 Radio Astronomy

(1) Korean VLBI Network (KVN)

Korean VLBI Network (KVN) is the only VLBI facility in Korea. It consists of three 21m radio telescopes, which are located in Seoul (Yonsei University), Ulsan (University of Ulsan), and Jeju island (Tamna University), and produce an effective spatial resolution equivalent to that of a 500km radio telescope. Compared to American and European VLBI networks such as VLBA and EVN, the size of KVN is still small. In order to overcome this shortcoming, KASI

is developing innovative multi-frequency band receiver systems with which we will be able to make simultaneous VLBI observations at four different frequencies: 22GHz, 43GHz, 86GHz, and 129GHz. Since millimeter-wave VLBI (mm-VLBI) is still in the developing stages around the world, we expect that KVN will play an important role in promoting mm-VLBI research activities. In addition, KVN will often be operated in combination with Japanese and Chinese VLBI networks to form the

so-called East Asian VLBI Network (EAVN), which is expected to be comparable to VLBA and EVN in spatial resolution, sensitivity, and imaging fidelity. KVN will provide opportunities to study the formation and death processes of stars, the structure and dynamics of our own galaxy, the nature of active galactic nuclei and so on at milli-arcsecond resolutions. KVN can be also utilized to precisely detect tectonic movements in the Korean peninsula. In addition, KASI is building the Korea-Japan joint VLBI correlator, in collaboration with the national astronomical observatory of Japan.

The first set of 22/43GHz receivers were installed at the KVN Yosei telescope in August 2008. The first fringes were detected in the VLBI test observations with the Japanese VLBI network VERA at both frequencies. KVN Yonsei telescope is operational as a single dish. The VLBI test observations are being carried out to evaluate and to improve the performance. Second and third sets of 22/43GHz receivers will be installed on the other telescopes towards the end of 2009. All KVN telescopes will be equipped with 22/43/86/129GHz receivers in 2011. As the world's first dedicated mm-VLBI network, KVN will help KASI take another major step up to the next level of radio astronomy. More detailed information about KVN is in the following section.

(2) KVN Sites

Three KVN observatory sites have been selected among many competitors. The first table below presents the locations, while the second table lists the baseline lengths, ranging between 300 km and 500 km. The antenna constructions were finished at all three sites in 2008. Fig. 12 shows an example of the u-v coverage and the synthesized beam for the combination of three KVN antennas and the TRAO 14-m radio telescope located at KASI headquarters in Daejeon. In future, these four antennas will be connected using the optical fiber networks both for the real-time unmanned operations and for 'online' operations (e-VLBI).

KVN site	Longitude (East)	Latitude (North)
Yonsei (Seoul)	126° 56' 35"	37° 33' 44"
Ulsan (Ulsan)	129° 15' 04"	35° 32' 33"
Tamna (Jeju)	126° 27' 43"	33° 17' 18"
TRAO (Daejeon)	127° 22' 19"	36° 23' 53"

	Yonsei (Seoul)	Ulsan (Ulsan)	Tamna (Jeju)	TRAO (Daejeon)
Yonsei (Seoul)	-	305.2	477.7	135.1
Ulsan (Ulsan)	305.2	-	358.5	194.2
Tamna (Jeju)	477.7	358.5	-	356.0
TRAO (Daejeon)	135.1	194.2	356.0	-



Fig. 11 Three KVN 21m radio telescopes

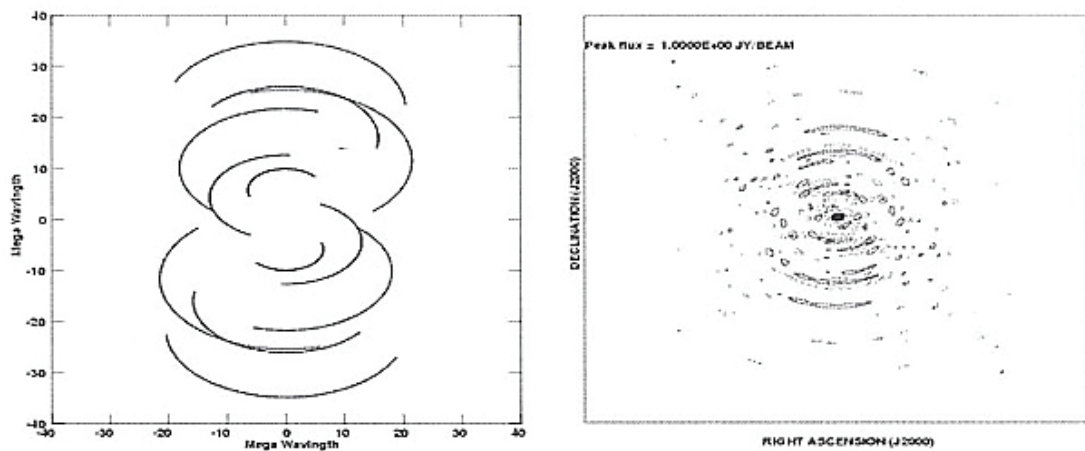


Fig. 12 Example u-v coverage (left) and synthesized beam (right) of KVN plus TRAO 14m telescope for a source with a declination of 60°

(3) KVN 21m Antennas

The KVN antennas are shaped Cassegrain antennas with a diameter of 21m. They were built in between September 2006 and September 2008. Fig. 11 shows three KVN sites with the 21m antennas. The surface accuracies of the primary reflectors are $\leq 150 \mu\text{m}$ rms and the aperture efficiencies are about 50%, 70%, and 70% at 22GHz, 43GHz and 100GHz respectively, with the pointing accuracy of each antenna estimated to be greater than 4" rms. The maximum slewing speed is $3^\circ/\text{sec}$ in both azimuthal and elevation angles with an acceleration of $3^\circ/\text{sec}^2$. This high slewing speed ensures weak source detection via 'fast position switching phase referencing'.

(4) KVN Receiver System

For the KVN front-ends, several cryogenic HEMT receivers will be installed at the Cassegrain focus for 2/8GHz, 22GHz, 43GHz, and 86GHz, and a SIS receiver for 129GHz operations. The 2/8GHz receivers will mainly be used for geodetic observations, whereas the others will be used for astronomical purposes. The 22/43GHz receivers will be installed first to set up the antennas and for the initial VLBI observations. The 86/129GHz receivers will be installed by 2011. Full polarization observation mode will be supported at 22GHz, 43GHz, 86GHz, and 129GHz.

For KVN, which is designed for mm-VLBI, we adopt an innovative multi-channel quasi-optical beam transportation system, which can be used for simultaneous on-source phase referencing of mm-VLBI, without losing observing time, and without the necessity for looking for reference sources. In addition, this method enables us to observe at four frequencies simultaneously. Fig. 12 (left) shows a schematic diagram of the KVN beam transporting system employing low-pass filters, while Fig. 12 (right) displays the lower frequency part of the beam transporting system currently installed at the KVN Yonsei telescope.

The 22GHz band is used as a phase calibration reference for the higher frequency band observations, made toward the same source at the same times. This multi-channel idea is expected to give very reliable phase corrections in mm-VLBI.

(5) KVN DAS and MK5 Recorder

The KVN Data Acquisition System (DAS) was developed and installed at all stations in 2008. For our multi-channel receiver system, we employ four high-speed samplers operating at 1Gbps. These four data streams of 2Gbps are transported via optical fibers to the operation

building, and then distributed between sixteen finite-impulse-response digital filters. With these filters, we can choose a passband (whose center frequency is arbitrarily programmable in the input bandwidth) and then resample the filtered data at 2 bits per sample. These re-sampled data streams are then formatted and sent to the recorder. The digital spectrometers are deployed for single-dish observations of total-power and polarization.

KASI participated in the Mark5 VLBI recorder development consortium. The KVN-Mark5B is designed to fully support VLBI standard interface specification. With this new recording system, not only highly sensitive offline observations but also e-VLBI are possible. e-VLBI will ensure more reliable VLBI operations for astronomy, astrometry, geodesy, and space missions.

(6) EAVN

As mentioned earlier, KVN will often operate together with Japanese and Chinese VLBI networks to form EAVN. EAVN for 22GHz will consist of 19 antennas scattered over 5,000km, while EAVN for 43GHz will comprise nine antennas. In May 2009 the first fringes of EAVN for 22GHz were successfully detected. Fig. 13 shows the results. Fully-fledged observations using EAVN are expected to get underway in 2010.

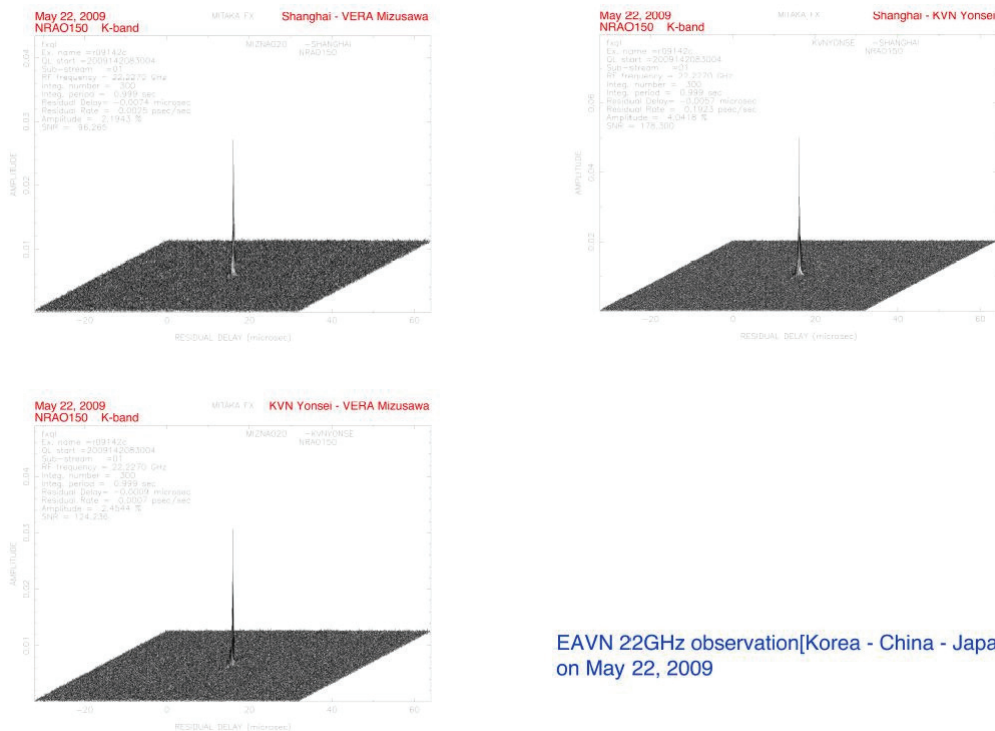


Fig. 13 First fringes of K-band EAVN (KVN Yonsei-VERA-CVN Sheshan)

3.1.3 Space Science

□ Space Geodesy

(1) Research

Space geodesy research in KASI is based on space geodetic technologies like GPS, VLBI, SLR and Gravimeter. These are focused on the Earth's shape and its geodynamic changes, i.e. terrestrial reference frame and Earth orientation parameters. These efforts are based on the three pillars of geodesy: geo-kinematics, Earth rotation, and gravity field (Fig. 13). KASI also works on applications of space geodesy like an early warning system for natural hazards such as bad weather, earthquakes, climate changes, ionospheric disturbance, etc. (Fig.s 14 and 15). KASI has carried out several research projects related to the above topics. Of these, our major interests are the development of an integration and application system of space geodetic techniques, the development of global navigation satellite system (GNSS) supplied techniques for weather forecasting, and the development of continuous monitoring technologies for torrential rain, radio interference, and tectonic deformation based on GPS. This research will be KASI's contribution to the Global Earth Observation System of Systems (GEOSS) and the Global Geodetic Observing System (GGOS).

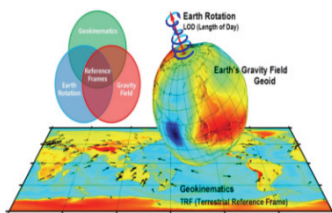
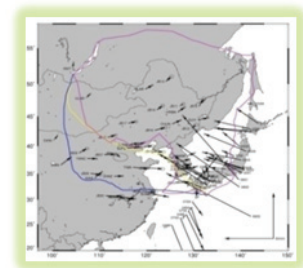


Fig. 14 GPS troposphere



Fig. 15 Amurian plate tectonics



(2) Applications

KASI operates its own GPS Network (KGN), which consists of nine domestic GPS stations (see Fig. 16). KASI collects the KGN observation data and generates various products for scientific research and its applications. Archived data and products are open to the public through the KGN data center. The KGN data are used for various science and engineering areas such as geodesy, surveying, and real-time high accuracy positioning. KASI is a leading R&D organ-

ization the high precision GPS data processing and real-time practical GPS applications. KASI has developed real-time kinematic and high accuracy differential GPS applications like real-time GPS data service via wireless communication network. Recently, KASI participated in the Korea multi-purpose satellite program (KOMPSAT-5) to extend its research areas to space-based GPS applications (Fig. 17).



Fig. 16 KASI GPS Network



Fig. 17 GPS receiver for KOMSAT-5

Solar and Space Weather

Solar and space weather research will be fully dealt with in Section 3.2 as one of KASI's key research areas.

3.1.4 Space Astronomy

The space era, initiated together with space ships, gave birth to space astronomy. Space astronomy changes the conventional concept of astronomy from ground observations to those from space. Space observations indeed promise us an unprecedented understanding of the universe, through its entire electromagnetic wavelength, without worries of atmospheric extinction. KASI's space science research group was officially established in 1997 to promote space astronomical research activities and to develop a payload system for the current Korean space program. Having succeeded in the development of the low light level CCD camera and the x-ray detector for the Korean sounding rocket program, KASI constructed the Far-ultraviolet IMaging Spectrograph (FIMS) in collaboration with Korea Advanced Institute of Science and Technology (KAIST) and UC Berkeley. FIMS (also called SPEAR), the first Korean-made space telescope, is the primary payload for the Science and Technology Satellite 1 (STSAT-1, Fig. 18 left), launched in September 2003. FIMS has conducted a first-of-its-kind survey which successfully produced a half-sky far-ultraviolet map that shows emission lines of hot gas rang-

ing from tens of thousands to several million degrees Kelvin. Since KASI is concerned with the design and construction of space payloads, the institute started to run its own laboratories and facilities for optical, ultraviolet, and near-infrared astronomy.

Based on the technology obtained in developments of the KASI near-infrared camera system on BOAO 1.8m telescope and the infrared instruments of the Cosmic Infrared Background ExpeRiment (CIBER) sounding rocket program in collaboration with NASA and JAXA, KASI's space astronomy research group is now developing the Multipurpose InfraRed Imaging System (MIRIS, Fig. 18 right) which is the main payload of STSAT-3. The MIRIS will produce imaging with a wide field of view ($3.67^\circ \times 3.67^\circ$) with a wavelength coverage from $0.9\mu\text{m}$ to $2\mu\text{m}$. To reduce thermal noise, the telescope temperature will be cooled down to 200K for space observation by radiative cooling. The main scientific purposes are to survey the galactic plane in Paschen alpha ($1.88\mu\text{m}$) emission line, and to observe the Cosmic Infrared Background (CIB) in two wide bands (I and H bands). The Paschen alpha survey will reveal the origin of warm ionized medium (WIM) which is a major component of the interstellar medium of the Milky Way. The structure information of WIM enables us to find the physical properties of interstellar turbulence related to star formation. In order to understand the origin of the first generation of massive stars (Population III stars) which caused the reionization of the universe, the MIRIS will observe the CIB for the north ecliptic pole region in two wide bands. The large sky coverage ($10^\circ \times 10^\circ$) can clearly measure the large-scale CIB fluctuations detected by the IRTS (InfraRed Telescope in Space) mission.

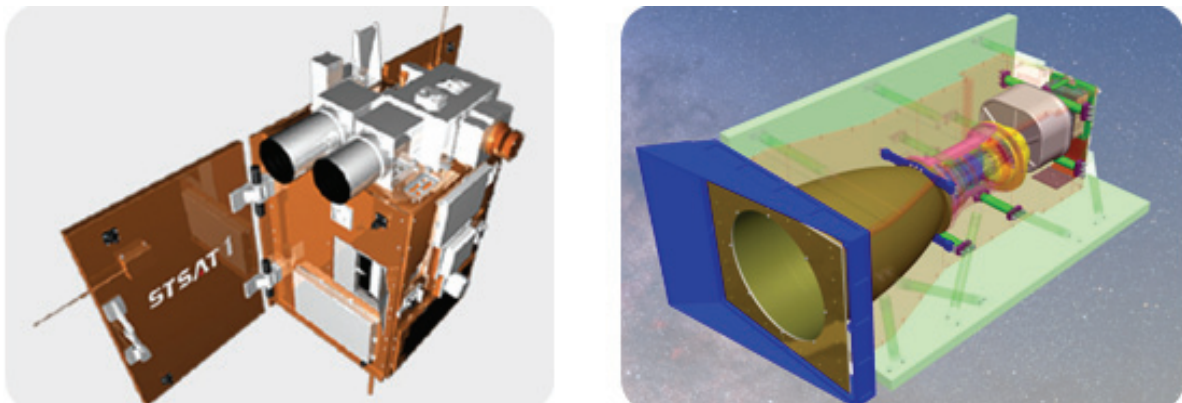


Fig. 18 Science and Technology Satellite 1 (STSAT-1, left) and Multipurpose InfraRed Imaging System(MIRIS, right)

3.2 Key Research Areas

3.2.1 Search for Extra-Solar Planets

Current Status

The primary scientific goal of our group is to search for extra-solar planets through various observational methods and to investigate their physical properties. The discovery of extra-solar planets, especially Earth-like planets in the habitable zone, is thought to be very important from both scientific and social points of view because it is the first step to study whether there is any life in the universe except for that on Earth. This is the reason why the survey of extra-solar planets tends to be ranked as one of a few key research themes of the recent major projects to construct large space- or ground-based telescopes.

Since the first discovery of planets around the pulsar PSR1257+12 in 1992, more than 450 extra-solar planets have been detected to date (April, 2010). About 93% of them (~420 planets) were discovered by the radial velocity technique which detects the radial-velocity variation due to the Doppler Effect by invisible planets revolving around a star. Among these ~420 planets, ~80 planets go around their parent stars with a high orbital inclination up to about 90 degrees, and this results in the photometric transit event; i.e. the brightness of a star decreases due to the blocking of a planet which passes across the stellar surface.

Since 2005, our group has been participating in the international research collaboration MicroFUN (Microlensing Follow-Up Network), to search for extra-solar planets by the microlensing technique. When two stars are exactly aligned in the line of sight of an observer, the brightness of the closer star greatly increases due to the gravitational effect. The closer star acts as a lens to make focus the light from the distant star. When there are planets revolving around the closer star, it acts as an imperfect lens and this leads to peculiar light variations. Our group (as members of the MicroFUN group) has discovered seven planets out of total of ten planets discovered by this microlensing technique.

In February 2009, we presented the first discovery of a multiple-planet system which had formed at a proto-planetary disk and which revolves around two parent stars. The two planets going around the eclipsing binary HW Vir are the first ones unequivocally discovered by using the eclipse timing method. When a planet and a star revolve around a common center of mass, the distance of the star changes periodically and this leads to a variation of light-travel-time from the star to an observer. For eclipsing binaries, we can find extra-solar planets

from the periodic variation of the eclipsing minimum epoch. In the same way, for pulsating stars we examine the variations of the pulsating maximum epoch. Since 2007, we have been participating in the multi-site campaign named EXOTIME (EXOplanet search with the Timing Method) to search for planets in the pulsating sdB stars.

We have presented a total of 75 research papers in foreign SCI journals over the past five years (2005-2009; see Appendix). The five journals (ApJ, MNRAS, AJ, A&Ap and PASP) in which most of our papers have been published have impact factors higher than 3.5 and are ranked as the top five journals by the astronomical society.

We started a new R&D project to develop a wide-field survey system in January 2009. The system will be one of a few international leading observation facilities for the discovery of extra-solar planets.

Personnel

Our group consists of seven researchers. All are experts on the observational study of variable objects (eclipsing binaries, pulsating stars and microlensing) which are directly related to the survey of extra-solar planets.

(Unit: Persons)

Majors	Degrees	Number of Staff (regular/temporary)
Eclipsing binaries Kim, Ho-Il Lee, Chunk-Uk Lee, Jae Woo	Ph.D. Ph.D. Ph.D.	3(3/0)
Pulsating stars Kim, Seung-Lee Jeon, Young-Beom	Ph.D. Ph.D.	2(2/0)
Microlensing Park, Byeong-Gon Chung, Sun-Ju	Ph.D. Ph.D.	2(1/1)

Major Research Projects and Budget

Our group is carrying out two research projects: one on the observational survey of variable objects; and the other on the development of the extra-solar planet survey system. The primary goal of the former project is to observe time-varying phenomena of variable objects and to investigate their physical properties. The observations are made by the photometric and spectroscopic facilities operated by KASI. This research has resulted in the discovery of new celestial objects like extra-solar planets to make the variations. By comparing observational results and theoretical

modeling, we can study the formation and evolution of extra-solar planets and of variable stars. The project started in 2005 and the annual budget is about 250 million Korean Won.

The primary purpose of the latter project is to construct a wide-field photometric survey system in the southern hemisphere. The key scientific goal of this project is to discover multiple extra-solar planets, especially Earth-mass planets in the habitable zone, by means of the microlensing technique. The scientific goal requires continuous observation with high cadence of about ten minutes for tens of millions of stars. We will therefore monitor dense star fields towards the Galactic Bulge. A huge number of variable objects and hundreds of extra-solar planets are expected to be discovered by this project. The project started in 2009 and will continue for at least ten years. The total budget of this project is about 30,000 million Korean Won.

(Unit: KRW)

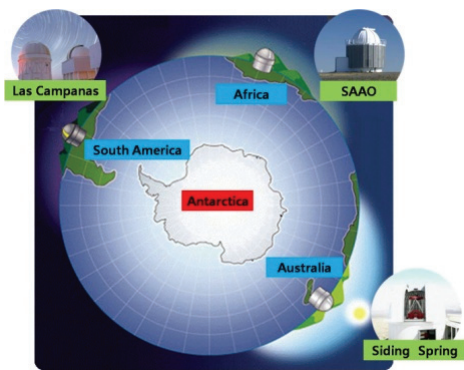
Projects	Budget
<p>Observational Survey of Variable Objects</p> <p>The project is to perform time-series observations of variable objects and to search for extra-solar planets. We have been participating in multi-site observation campaigns for these objects. The final goal of this project is to become an international leading group in this research field.</p>	<p>~250,000,000 per year</p>
<p>Development of the Extra-solar Planet Survey System</p> <p>The project is to manufacture a photometric survey system consisting of wide-field telescopes and ultra-large format cameras. The system will be installed at three observation sites in the southern hemisphere and be used for 24-hour uninterrupted monitoring of the Galactic Bulge. From this survey system, we expect to produce international leading results such as the discovery of multiple new extra-solar planets.</p> <div style="text-align: center;">  </div>	<p>30,000,000,000 for 10 years</p>

Fig. 19 Three southern observation sites where the survey system will be installed by 2004.

□ Research Achievements

(1) The first discovery of a Jupiter/Saturn analog

The microlensing technique for searching for extra-solar planets is potentially sensitive to multiple-planet systems containing analogs of all planets in our solar system. We detected a multiple-planet system by this technique. On 28 March 2006 the OGLE Early Warning System announced OGLE-2006-BLG-109 as a nonstandard microlensing event possibly indicative of a planet. As a part of follow-up observations in the MicroFUN group, two members (Park B.-G. and Lee C.-U.) of our group carried out time-series photometry using the 1.0m telescope at Mt. Lemmon Optical Astronomy Observatory. The telescope has been remotely operated by KASI. They went on to process all the observational data obtained at several MicroFUN sites.

A total of 2671 data points were analyzed to find the best fitting parameters for the microlensing model. The analysis resulted in the detection of two planets with masses of 0.71 and 0.27 times Jupiter's mass, and with orbital separations of 2.3 and 4.6 AU from a parent star. The star is located at a distance of 1.5 kpc from the Earth. The OGLE-2006-BLG-109L planetary system bears a remarkable similarity to our own solar system. Although the parent star has only half the mass of our sun, the mass ratios of the two planets and the ratios of their separations (semi-axis distances from the parent star) are similar to those of Jupiter and Saturn. Their equilibrium temperatures were estimated to be ~82 K and ~59 K, 30% lower than those of Jupiter and Saturn. This planetary system resembles a scaled version of our solar system in that the mass ratio, separation ratio and equilibrium temperatures of the planets are similar to those of Jupiter and Saturn. These planets cannot be detected by the other techniques. Among only ten planets discovered by the microlensing technique, we detected this multiple-planet system, suggesting that solar system analogs may be common in the universe. This result was published in the journal *Science* in February 2008.

(2) Discovery of circum-binary planets orbiting the eclipsing binary system HW Virginis

In 2009, three members of our group (Lee J.W., Kim S.-L. and Lee C.-U.) discovered two substellar companions revolving around the eclipsing binary system HW Vir. Considering theories of formation and evolution, we suggest that both substellar companions are planets formed simultaneously in a proto-planetary disk. The two objects are the first circum-binary planets known to have been formed in a proto-planetary disk as well the first ones unequivocally discovered by the eclipse timing method. The detection implies that planets may be common around binary stars just as planets are common around single stars. It also demonstrates that planetary systems formed in a circum-binary disk can survive over long time-scales.

Characterization of such planets is potentially of great interest because they could provide constraints and information on planet formation and evolution that are possibly different from those for planets orbiting single stars. We estimated their effective temperatures to be ~ 230 K and ~ 270 K, being about two times that of Jupiter.

Like the double sunset that Luke Skywalker saw in the well-known movie *Star Wars*, it is not difficult to imagine a planet with two suns. Our discovery shows that planets may be as common around binary stars as around single stars and suggests that the universe might be filled with them. Hence, the double sunset in Luke Skywalker's home planet Tatooine is not just a fantasy. The orbital separations and periods of the two planets are similar to those of the asteroid belt-Jupiter system in our solar system. This means that other solar systems may resemble our own and that solar system analogs may be prevalent among planetary systems.



Fig. 20 A schematic image of the circum-binary planets around the eclipsing binary HW Vir

Future Plans

Our group investigates the physical properties of variable objects and of extra-solar planets by multiple observational techniques. Up until now, we have used the three optical telescopes which have been operated by KASI and which were manufactured for general astronomical purposes. In January 2009 we initiated a new R&D project to develop a wide-field photometric survey system named KMTNet (Korea Microlensing Telescope Network). The system is a dedicated facility for the sole scientific purpose of detecting extra-solar planets. When the installation of the system is finished in 2004, we expect that it will be one of a few international leading observation facilities. The system will monitor dense star fields toward the Galactic Bulge from three southern hemisphere observatories. A huge amount of observational

data for tens of millions of stars will enable us to discover multiple new variable objects and extra-solar planets.

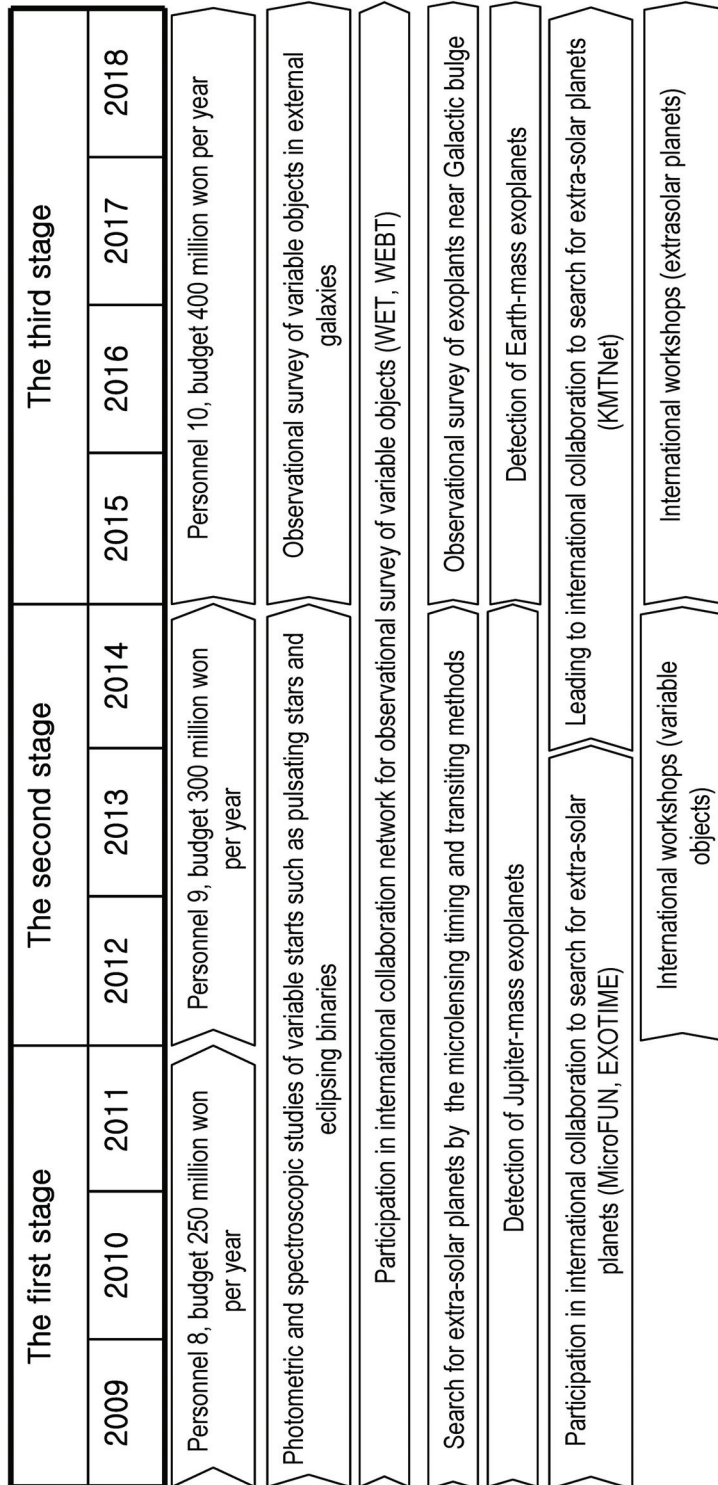


Fig. 21 A long-term roadmap of Search for Extra-solar Planets in KASI

3.2.2 Solar Physics, and Space Weather

Current Status

The sun is not as quiet as it seems. It produces sudden events, namely solar flares and coronal mass ejections (CMEs). Solar flares release intense radiation in the form of x-rays and radio waves. CMEs are billions of tons of gas moving into the interplanetary space. Usually, Earth's magnetosphere deflects most of the solar wind and high-energy particles from the sun. However, sometimes these solar activities significantly change the Earth's magnetosphere and cause high energy particles to directly reach the upper atmosphere of the Earth, producing aurora. This environmental change of space, the sun, solar wind, the geo-magnetosphere, and Earth's ionosphere and thermosphere is popularly known as "space weather" or "space environment". As civilization moves into space, we rely on space-borne technologies (e.g. satellites) that are vulnerable to space weather. The effects of space weather on modern technological systems are therefore of growing interest around the world.

The SOLar and Space weather research group (SOS) is actively involved in front-line research in the field of solar activity and space weather. Currently we are managing the SOLar Flare Telescope (SOFT), a solar spectroscopy telescope, a sunspot telescope, a solar radio spectrograph, magnetometers, a scintillation monitor, and an all-sky imager. We have been observing sunspots since 1987 using the sunspot telescope, and solar flares since 1995 using SOFT at Bohyunsan Optical Astronomy Observatory (BOAO). In particular, SOFT observes solar activities in multiple channels simultaneously, i.e. white light, H-alpha, and magneto-active spectral lines, to understand more detailed dynamics and the magnetic nature of solar activities. We have also made spectroscopic observations using a Coelostat-type solar spectroscopy telescope since 2002. Recognizing these achievements, in 2001, the SOS was chosen as the solar activity research laboratory (one of the National Research Laboratories) for the Ministry of Science and Technology of the Korean Government. Since then, we have developed a solar full-disk monitoring system which consists of an H-alpha full-disk imager and a coronagraphic polarimeter.

In 2004, we initiated a new project, which comprises the development of Korean Solar Radio Burst Locator (K-SRBL) and participation in the construction of a 1.6m New Solar Telescope (NST). In addition, since 2007 SOS has been carrying out a new project to establish a Korean space weather prediction center for domestic satellites and communication systems. The scope of the project includes the extension of the ground observation system,

the construction of a space weather database and network, the development of prediction models, and space weather studies.

Through these projects, we are not only developing observational systems that can monitor solar activities and space weather, but also concentrating on the research of space weather and its effects on modern space technologies.

□ Personnel

Solar and space weather research involves different kinds of environments including the sun and the solar atmosphere, the space between the sun and Earth (which is pervaded by high energy particles from the sun), and near-Earth space, including the magnetosphere and the upper atmosphere of the Earth. Group members therefore have a variety of major fields i.e. solar physics (11), solar wind (2), magnetosphere (4), ionosphere/upper atmosphere (2), and software engineering (3). Among eight regular staff, seven are research scientists and the other is a software engineer.

(Unit : Persons)

Majors	Degrees	Number of Staff (regular/temporary)
Solar physics	B.S.	2(0/2)
	M.S.	3(0/3)
	Ph.D.	6(4/2)
Solar wind	M.S.	1(0/1)
	Ph.D.	1(0/1)
Magnetosphere	B.S.	2(0/2)
	Ph.D.	2(2/0)
Ionosphere/upper Atmosphere	B.S.	1(0/1)
	Ph.D.	1(1/0)
Software engineer	B.S.	1(0/1)
	M.S.	2(1/1)
Total		22(8/14)

□ Major Research Projects and Budget

The SOS (SOLAR and Space weather group) has been carrying out three major projects: (1) the construction of a space weather prediction center (hereafter the space weather project), (2) a study of the effects of CME and high speed solar wind in the near-Earth space (hereafter the leading research project), and (3) the operation of a solar observation system (hereafter the instrument operation project). The annual budget of our group is between 1 and 1.5 million US dollars.

(Unit: KRW)

Projects	Budget
- Construction of Space Weather Prediction Center (the space weather project)	2,450,000,000(total)
: Extension of ground observation system	- (2005)
: Construction of space weather database and networking	- (2006)
: Development of Space weather prediction models	600,000,000(2007)
: Investigation on Space weather effects	1,000,000,000(2008)
	850,000,000(2009)
- Study on Effects of CME and High Speed Solar Wind in the near-Earth Space (the leading research project)	641,000,000(total)
: Study on Solar Eruption Phenomena	60,000,000(2005)
: Study on physical parameter changes of the near-Earth space	90,000,000(2006)
: Study on ionospheric/upper atmospheric variations associated with near-Earth space environment's change	150,000,000(2007)
	141,000,000(2008)
	200,000,000(2009)
- Operation of Solar Observation Systems (the instrument operation project)	715,000,000(total)
: Operation and maintenance of solar telescopes	65,000,000(2005)
: Observation of solar activities	90,000,000(2006)
: Observations of the sun using 1.6 meter New Solar Telescope	75,000,000(2007)
	215,000,000(2008)
	270,000,000(2009)

□ Research Achievements

(1) Construction of research instruments

As mentioned above, SOS has been making sunspot observations since 1987 using the sunspot telescope, which is a 20cm refracting telescope. In 1995 the solar flare telescope (SOFT) was installed at BOAO to observe solar activities in white-light and H-alpha wavelengths and to obtain the vector magnetogram of the photosphere. In 2002, we also installed the solar spectroscopy telescope to observe the solar spectrum of the active region and to calibrate the solar filters that were used for our solar telescopes.

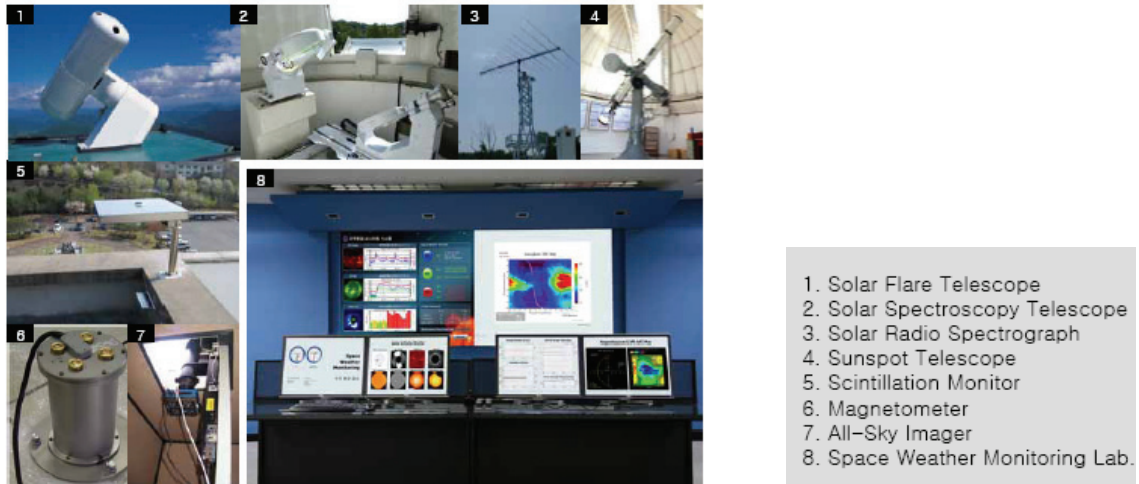


Fig. 22 Observation systems of solar and space weather research group

As a part of the space weather project, SOS has installed a magnetometer at BOAO for the space weather study and a global network of frequency-agile radio spectrometers which were constructed in collaboration with ETHZ, Switzerland. For the study of the ionosphere/upper atmosphere under the project, SOS also installed an all-sky imager and a scintillation monitor. Keeping pace with the initiation of the space weather project, SOS launched the Space Weather Monitoring Laboratory (SWML) in KASI headquarters and has been providing several kinds of space weather information to the public since 2007.

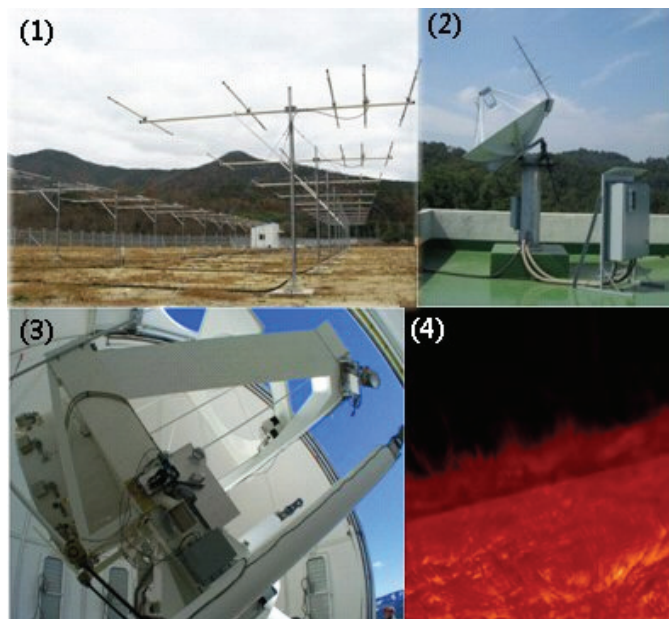


Fig. 23 Recently installed instruments: (1) KASI-CSR, (2) KSRBL, (3) NST at BBSO, and (4) solar north polar limb in H-alpha observation made by NST

Most recently, SOS installed coherent scatter radar (hereafter KASI-CSR) for study of the ionosphere. The range coverage of KASI-CSR is from 70km to 800km including the thermosphere and ionosphere. The KASI-CSR was established in the Korean Air Force region in 2009. In collaboration with the New Jersey Institute of Technology (NJIT), SOS installed the Korean Solar Radio Burst Locator (KSRBL) and participated in the development of a 1.6m New Solar Telescope (NST). The KSRBL was installed at KASI in August 2009, and the NST at Big Bear Solar Observatory (BBSO) got its first-light image in 2009; its Adaptive Optic (AO) system will be available in 2010. All these instruments will help us to concentrate on the deeper issues of solar activities and sun-Earth connection studies.

(2) Solar and space weather research

Solar and space weather research can be divided into three categories: (1) the study of solar eruption phenomena, (2) the study of physical parameter changes in the near-Earth space, and (3) the study of ionosphere/upper atmosphere variations associated with changes in the near-Earth space environment. SCI paper products are given below.

Research Fields	Results (2005-2009)
Study on the Solar Eruption Phenomena	SCI papers : 37
Study on the Physical Parameter Changes in the near-Earth Space	SCI papers : 17
Study on the Ionosphere/upper Atmosphere Variations Associated with near-Earth Space Environment's Change	SCI papers : 9
Total	SCI papers : 63

▷ Study on the solar eruption phenomena (Flare, CME, Prominence, Shock)

- Relationship between type II radio bursts and CME
- Magnetic reconnection of flare-associated CME
- Hinode observations of pre-flare, coronal jet and magnetic field structures in the solar active region
- Geomagnetic storm prediction associated with CME and high-speed solar wind streams
- CME kinematics and flare observations in the multi-frequency band (Fig. 24)

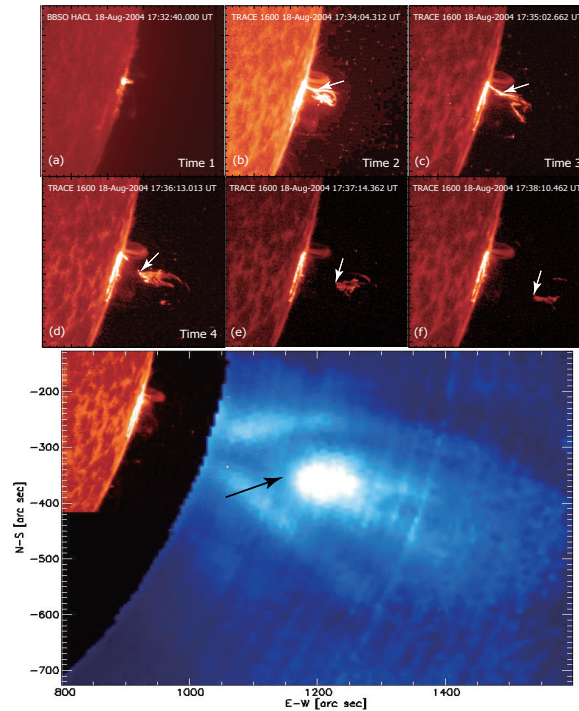


Fig. 24 Continuous evolution of the prominence to the CME. (Cho et al., APJ, 2009)

▷ **Study of physical parameter changes in the near-Earth space**

- Magnetic helicity
- Examination of space environment disturbances at geosynchronous
- Examination of magnetic field and space environment particle variations during strong and small scale space storms
- Relationship between CME initial speed and magnetic energy of magnetic clouds
- 1-AU IP shock propagation model using CME initial speed (Fig. 25)

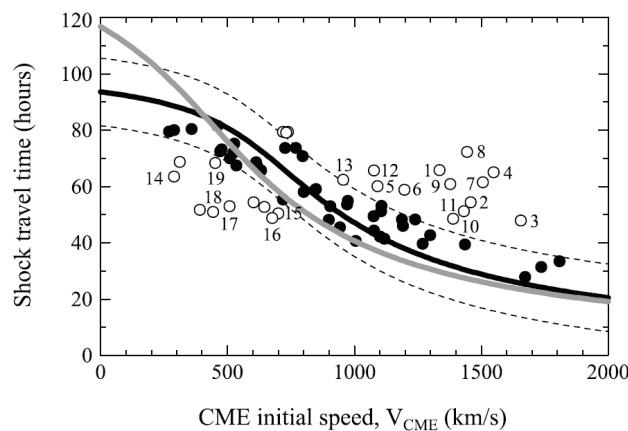


Fig. 25 IP shock traveltimes to 1 AU as a function of the CME initial speed during solar maximum. (Kim et al., JGR, 2008)

▷ Study of ionosphere/upper atmosphere variations associated with changes in the near-Earth space environment

- Atmospheric drag effect on LEO satellite during geo-magnetically disturbed interval
- Study of E- and F-region irregularities using ionospheric radar observations
- Study on plasma and/or neutral density variations by the interplanetary magnetic field (Fig. 26)

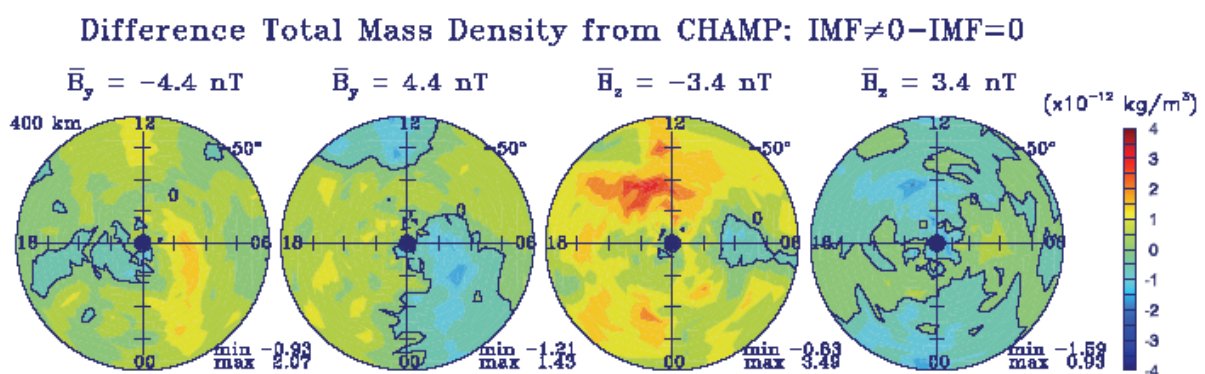


Fig. 26 Difference densities at 400 km altitude over the southern summer hemisphere for IMF (\bar{B}_y , \bar{B}_z) values of (left to right) (-4.4, 0.0), (+4.4, 0.0), (0.0, -3.4), and (0.0, +3.4) nT. (Kwak et al., JGR, 2009)

□ Future Plans

SOS will continue its studies of solar activities, the sun-Earth connection, and the near-Earth space environment as well as the extension of space weather observation facilities as shown in Fig.27 and 28. In the case of the observation facilities, we are operating several space weather observation facilities on the ground, i.e. solar telescopes, magnetometers, an ionospheric imager, radar and so on. In the near future, we will construct a space science observatory in the Antarctic in collaboration with the Korean Polar Research Institute (KOPRI). The observatory will be equipped with several kinds of ground-based observation systems; a magnetometer, an all sky camera, a neutron monitor, coherent scatter radar, an ionosonde, etc. In addition, we are preparing for the development of a space weather observation system in space with domestic and international collaboration. To date, there are some candidates for this, such as the Energization and Radiation in Geospace (ERG) mission in Japan, the Radiation Belt Storm Probe (RBSP) mission in USA, and a new space

mission developed by KASI.

In the case of solar and space weather research, first of all we will concentrate on the studies using high resolution observations of the sun: the New Solar Telescope (NST) and the Solar Dynamic Observatory (SDO). In particular, the NST science targets are as follows: high resolution studies of solar flares, structure/evolution of magnetic fields in the flaring active region, dynamics of k-Gauss flux tubes, magneto-convection in sunspots, and heating of the upper atmosphere. Owing to these high resolution observations with unprecedentedly high spatial and temporal resolution, we can understand the deeper issues of solar activities and sun-Earth connections. With the international collaboration for space missions in the near-Earth space (e.g. ERG and RBSP), we will focus on understanding the relationship between space storms and high energy particles and the energy exchange between the magnetosphere and the ionosphere/upper atmosphere.

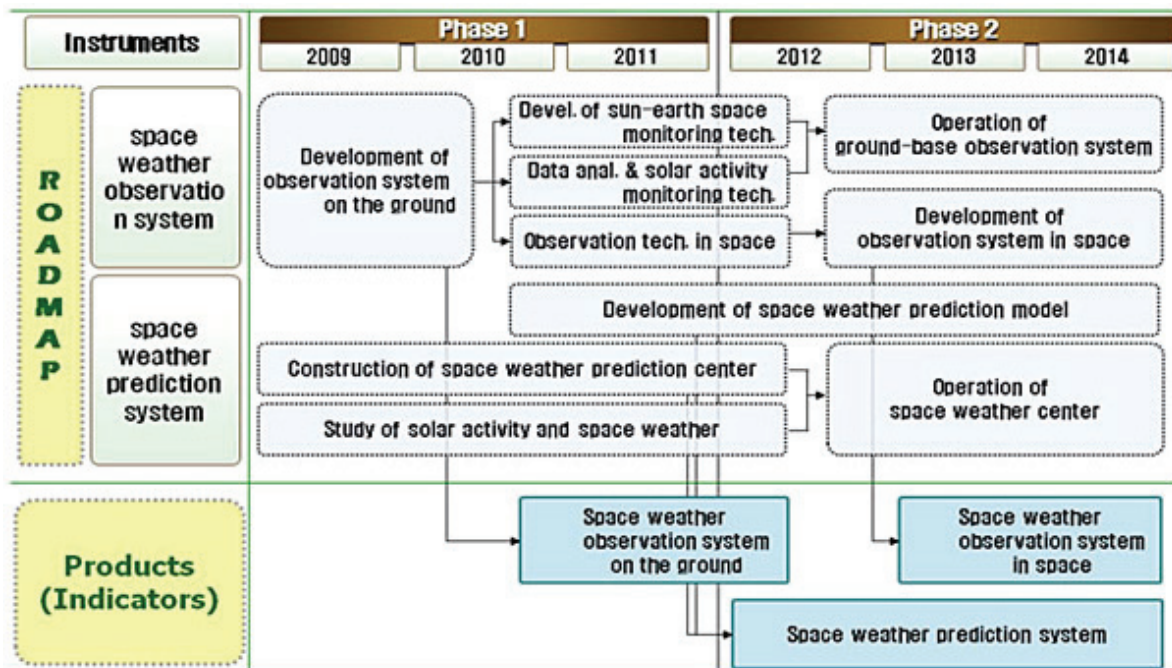


Fig. 27 Mid-term roadmap for instrument construction of the solar & space weather research group (SOS)

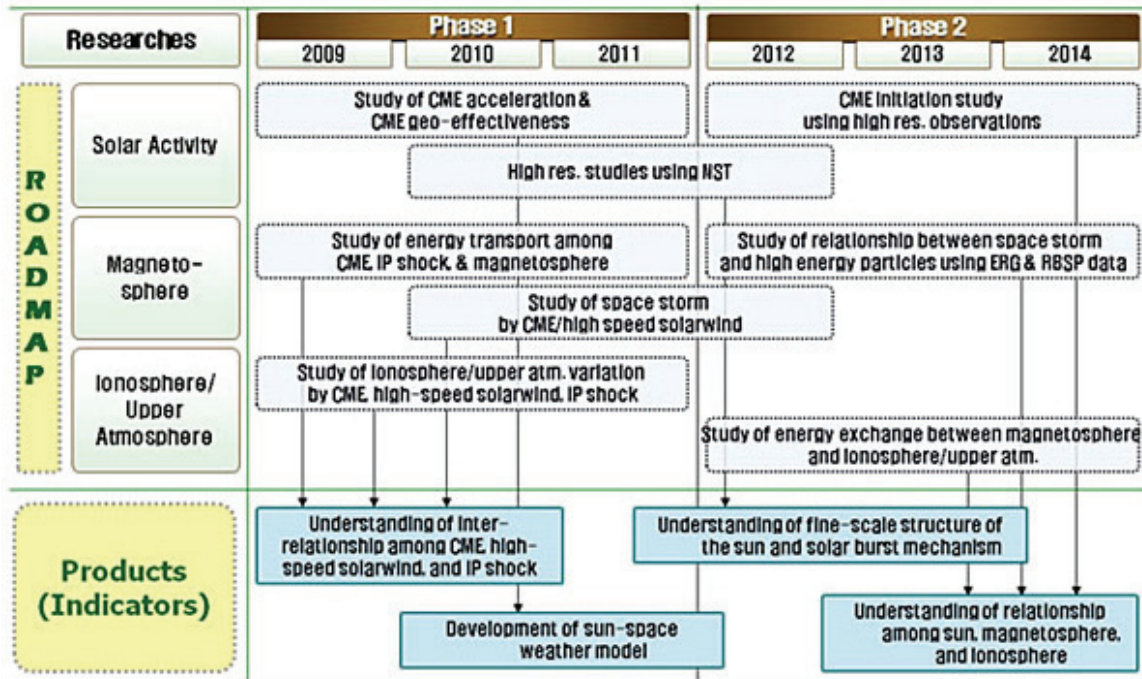


Fig. 28 Mid-term roadmap for solar and space weather researches of the SOS

In addition, we are looking for international partners who can exchange space weather information and/or carry out scientific collaboration for a better understanding of solar-terrestrial interaction.

4. Public Outreach, and Managerial Issues

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4. Public Outreach, and Managerial Issues

4.1 Public Outreach

4.1.1 RENEW Program

Unrelated to the usual public outreach activities which KASI has carried out, KASI established a mid-term public outreach program of three years to develop a consistent system to publicize astronomy and space science and to actively engage with the media. The program is called RENEW: Relationship, Education, Network, Excellency and Ways.

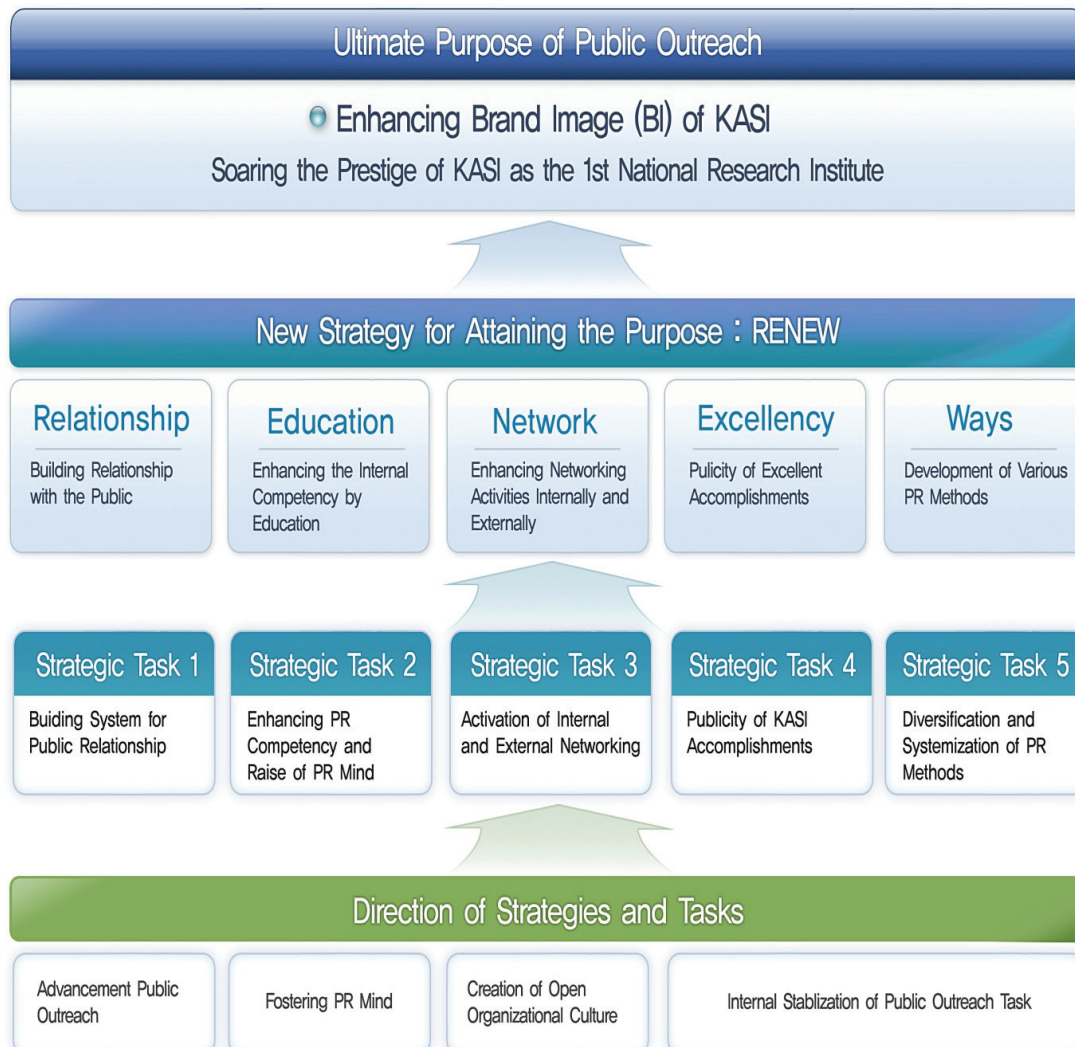


Fig. 29 Strategic map of the RENEW Program

The RENEW program has five strategic tasks and each task is linked to the goals below under four basic directions.

Task	Final Goal
Building Relationship with the Public	- Building infra and system to maintain consistent networking with the public
Enhancing the Internal Competency	- Fostering practical capability of PR staff by providing professional education - Developing PR mind to set in all the KASI staff by providing PR education
Enhancing Internal/ External Networking Activities	- Forming PR committee with the members in charge of PR from each division and holding regular committee meeting to identify remarkable KASI accomplishments and to carry out effective PR - Enhancing PR on astronomy through networking with astronomy-related organizations and press reporters and giving systematic support to them
Publicity of Excellent Accomplishments	- Raising public awareness on importance of astronomy and space science
Diversification and Systemization of PR Methods	- Development of customer-oriented science PR programs - Contributing to the spread of science culture to the fringe/ local areas and to people from various backgrounds

In 2009, KASI started strategic public outreach activities based on RENEW. While these have not achieved visible results yet, These activities are expected to contribute to the enhancement of KASI's PR capability and public awareness

4.1.2 International Year of Astronomy 2009 (IYA2009)

2009 was a year of global celebration for the astronomy community, and KASI, in official cooperation with the two Korean societies for astronomy and space science (KAS and KSSS), successfully carried out the IYA2009 program throughout the year.

Firstly, KASI organized a TF to prepare for IYA2009 and outlined the frame of IYA2009 in Korea. The outline report of IYA2009 in Korea shows five qualitative/quantitative goals, as follows:

- Qualitative Goals:

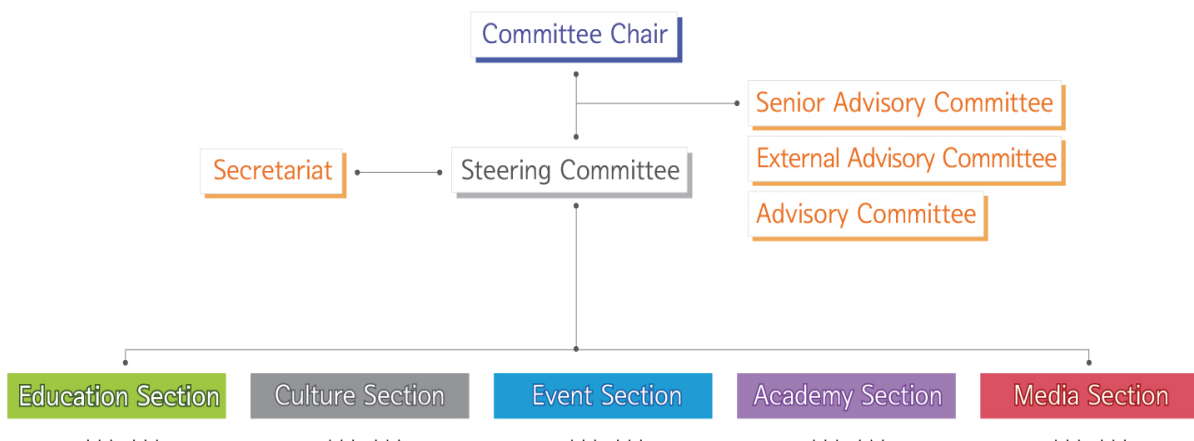
- 1) Active participation in the global events of IYA2009 through international cooperation,
- 2) Successful hosting of the domestic events of IYA2009 through cooperation with universities and other organizations,
- 3) Raising of the awareness of the young in astronomy and basic science through educational programs,
- 4) Propagation of the social and cultural aspects of astronomy and basic science through cultural programs,
- 5) Enhancement of the astronomical base in society through events and media programs

- Quantitative Goals:

- 1) Participation of over 0.5 million students and members of the general public,
- 2) Over 50 provincial exhibitions,
- 3) Publication of over five kinds of official books and pamphlets,
- 4) Raising of public awareness of IYA2009 by 5% from the previous year,
- 5) Over 500 reports of IYA2009 in the media.

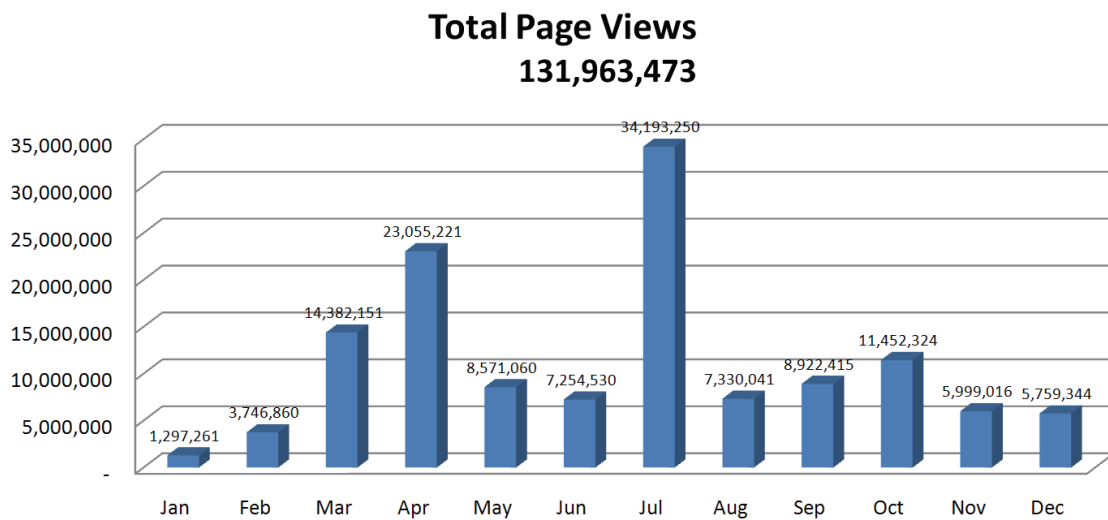
The Korean Committee for IYA2009 was organized in late 2008 and various projects were run in five departments.

+ IYA 2009 Organizational Structure +



Department (No. of Events)	Motto and Goal
Culture (189)	<Mystery of the Universe> - Cross-over programs to communicate between astronomy, art and humanities
Education (123)	<Dream and the Universe> - Educational programs for the students and teachers in elementary, middle and high school
Event (162)	<The Universe and Me> - Programs for the general public and children
Academy (7)	<Mystery of the Universe> - Domestic and international academic programs for the experts
Media (57)	<Media and the Universe> - Advertising programs via media such as internet, prints and broadcasts

Public attention to IYA2009 in Korea could be estimated by the number of page views on the official webzine, "IYAZINE".



IYA2009 in Korea itself was furnished with magnificent projects, and also became the perfect chance to explore new approaches and methods of public outreach in astronomy.



4.2 Managerial Issues

4.2.1 R&D Project Management

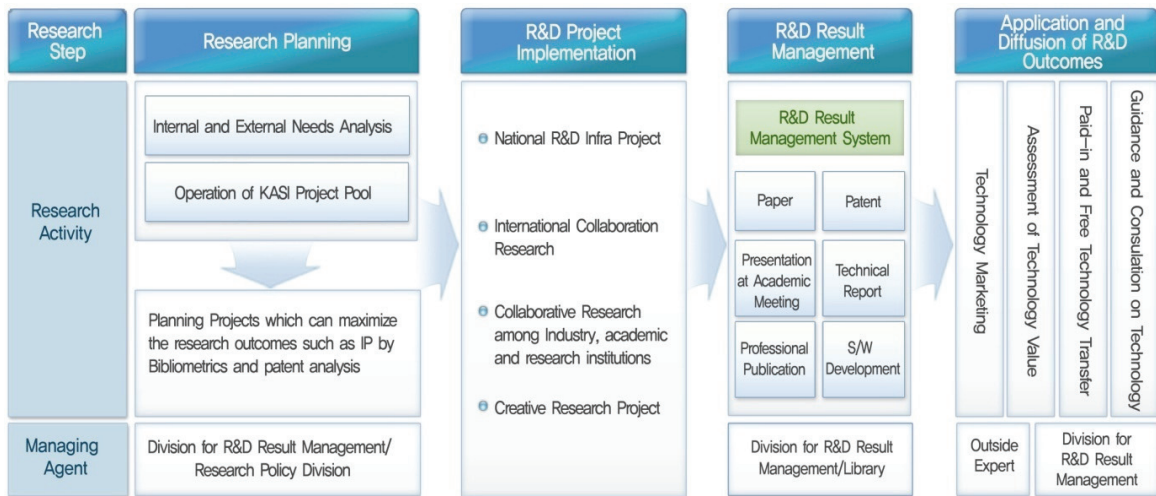
The R&D projects of KASI are managed by phased analysis and application. The overall activities for R&D are categorized into four steps.

1) Research Planning: To discover and reflect creative, promising R&D ideas, KASI thoroughly analyzes the needs of R&D staff. In particular, the project ideas of KASI staff are put into the KASI Project Pool, which is regularly examined and evaluated twice a year. In terms of research evaluation, these ideas are given constructive suggestions and comments at the open meeting. The selected R&D proposals are then launched as preliminary studies or entrusted projects. In particular, the preliminary studies are applied with various kinds of planning methodologies including SWOT analysis, bibliometrics, network analysis etc. to check the validity of the research planning.

2) R&D Project Implementation: The projects are carried out falling into four types: National R&D Infra Projects; International Collaboration Research; Collaborative Research With Industry, Academic and Research Institutions; and finally Creative Research Projects. During the implementation period, KASI monitors the progress of projects via SDSS (Strategic Decision Supporting System) and receives official progress reports twice a year.

3) R&D Results Management: The outputs of R&D project implementation are gathered in a R&D results management system according to their characteristics.

4) Application and Diffusion of R&D Outcomes: KASI as a government-funded research institute is endeavoring to promote the public benefits of its R&D outcomes. The scientific outcomes are applied to foster public understanding of science. Meanwhile, KASI is making efforts to diffuse the technological outcomes of its projects by way of technology transfer to industry, not to mention KASI's own commercialization including telescope manufacture for public use. For more extensive diffusion of technology outcomes of astronomy, KASI is planning to liaise with TLOs within Daedeok Innopolis (the governing institution of Daedeok Science Park).



4.2.2 HR Development Program

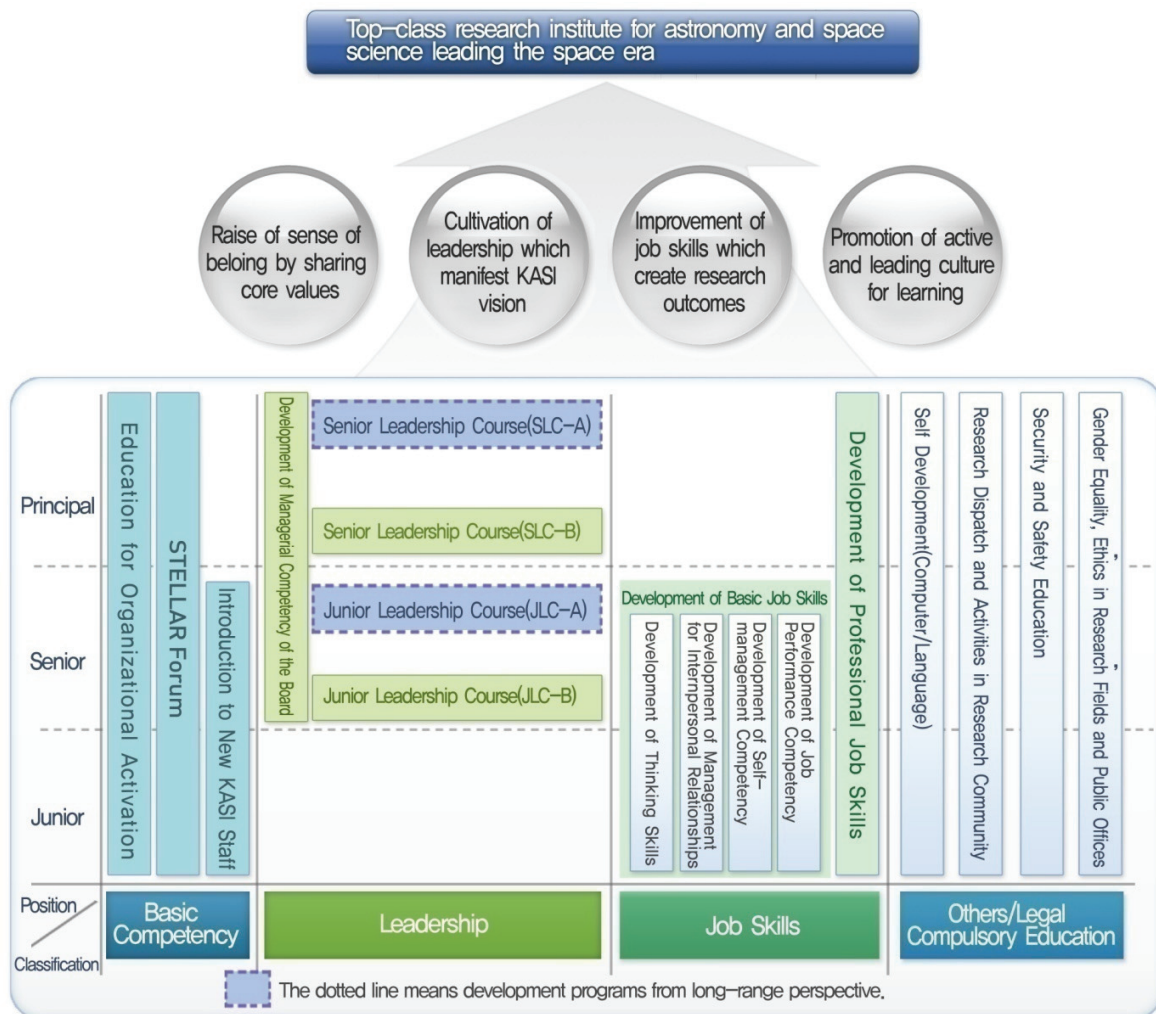


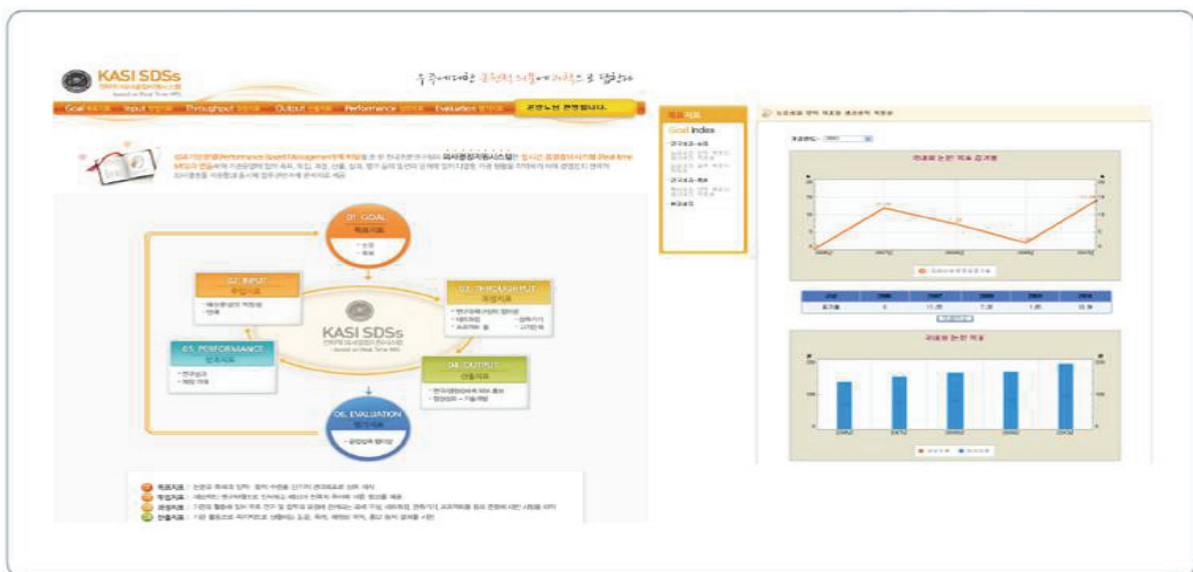
Fig. 30 Map of KASI HR Development

In the ten-year Long-range Plan for 10 years, KASI has drawn out a task for the fostering of human resources, specifying the enhancement of SHRM (Strategic Human Resource Management). The task entails two aspects of SHRM: firstly, in-service training for development of KASI employees; and secondly, the attraction of competent people along with the creation of an attractive working environment. The map above shows the system of KASI HR development for its employees. It combines individual aims and education with needs-oriented and customer-tailored education programs. The educational motto of 2010 is “leadership”, and the employees are being educated periodically based on their occupation, position and class. The satisfaction level of the educated employees is measured after every program and these results are reflected in the next HR development program. Furthermore, KASI includes the employees’ educational career in their promotion prospects and personal evaluations to foster enthusiastic participation in the program.

4.2.3 Strategic Decision Supporting System (SDSS)

SDSS was designed to provide objective and specific data helpful for decision-making for KASI's board of directors, and to ultimately promote KASI's R&D productivity. SDSS shows real-time information on the main research accomplishments and activities in the research and administrative areas. The data is presented in six steps: goal, input, process, output, outcome, and evaluation. They are subdivided into 35 indicators and again into 98 indexes. Massive amounts of material are converted into useful information, which is mostly statistics and visualized charts.

The real-time provision of strategic allocation of budget and manpower and the relevant results of outcome evaluation by SDSS is expected to raise managerial efficiency and the rationality of organizational decision-making.



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5. Appendix

5. Appendix

Appendix 1 Key Researchers in the Extra-Solar Planet Research Group

(1) Kim, Seung-Lee (Principal Researcher, Group Leader)

Date hired: January 15, 1996

Highest degree attained: Ph. D.

Major: Variable stars, stellar photometry

Institution that conferred highest degree: Seoul National University

Key achievements:

- 56 research papers in SCI journals over the past 15 years
- Discovery of hundreds of new variable stars in open clusters
- Discovery of nine new oscillating EA-type binaries
- Participation in two international collaborations, WET and EXOTIME

Career:

- August 25, 1996: Award of Ph.D.
- January 15, 1996 ~ present: Researcher at KASI
- March 1, 2008 ~ present: Professor at University of Science and Technology (UST)
- March 1, 2010 ~ present: A member of the editing committee for Publication of the Korean Astronomical Society (PKAS)

Representative published papers:

- Provencal J. L. et al. 2009, ApJ, "2006 Whole Earth Telescope Observations of GD358: A New Look at the Prototype DBV"
- Baran, A. et al. 2009, MNRAS, "The pulsating hot subdwarf Balloon 090100001: results of the 2005 multisite campaign"
- Koo, J.-R., Kim, S.-L., Rey, S.-C. et al. 2007, PASP, "Variable Stars in the Open Cluster M11 (NGC 6705)"
- Mkrtychian, D., Kim, S.-L., Kusakin, A. V. et al. 2006, Ap&SS, "A Search for Pulsating,

Mass-Accreting Components in Algol-Type Eclipsing Binaries”

- Kim, S.-L., Lee, J. W., Kim, C. et al. 2005, PASP, “photometric properties of the variable star LZ Her”

(2) Park, Byeong-Gon (Principal Researcher, Director)

Date hired: September 1, 1992

Highest degree attained: Ph. D.

Major: Open clusters, microlensing

Institution that conferred highest degree: Kyungpook National University

Key achievements:

- 47 research papers in SCI journals over the past 12 years
- Discovery of several extra-solar planets
- Development of CCD cameras for the 1.8m telescope at Mt. Bohyun

Career:

- February 25, 2001: Award of Ph.D
- September 1, 1992 - present: Researcher at KASI

Representative published papers:

- Dong, S. et al. 2009, ApJ, “OGLE-2005-BLG-071Lb, the Most Massive M Dwarf Planetary Companion?”
- Batista, V. et al. 2009, A&A, “Mass measurement of a single unseen star and planetary detection efficiency for OGLE 2007-BLG-050”
- Park, B.-G., Han, C. 2008, ApJ, “Color-Shift Measurement in Microlensing-induced Stellar Variation from Future Space-based Surveys”
- Kim, D. et al. 2007, ApJ, “Detection of M31 Binaries via High-Cadence Pixel-lensing Surveys”
- Park, B.-G., Jeon, Y.-B., Lee, C.-U., Han, C. 2006, ApJ, “Microlensing Sensitivity to Earth-Mass Planets in the Habitable Zone”

(3) Kim, Ho-II (Principal Researcher)

Date hired: February 5, 1990

Highest degree attained: Ph. D.

Major: Eclipsing binary stars, stellar photometry

Institution that conferred highest degree: Yonsei University

Key achievements:

- 84 research papers in journals and proceedings
- Working for Korean very large telescope projects including cooperation between KASI-CFHT and international workshops

Career:

- February 25, 1989: Award of Ph.D.
- February 5, 1990 - present: Researcher at KASI
- March 1, 2008 - February 28, 2010: Professor at Chungnam National University
- January 1, 2008 - December 31, 2009: General Secretary of the Korea Astronomy and Space Science Society
- SOC member of Korea-Thailand joint workshops

Representative published papers:

- Hwang, H. et al. 2008, ApJ, "The Globular Cluster System of M60 (NGC 4649). II. Kinematics of the Globular Cluster System"
- Lee, M. G. et al, 2008, ApJ, "The Globular Cluster System of M60 (NGC 4649). I. Canada-France-Hawaii Telescope MOS Spectroscopy and Database"
- Lee, J.W., Kim, H.-I., Kim, S.-L. 2007, PASP, "A Period Study and Spot Model for the Eclipsing Binary TU Bootis"
- Oh, K.-D., Kim, C.-H., Lee, W.-B., Kim, H.-I., Kang, Y. 2006, MNRAS, "BVR observations and period variation of the near-contact binary ZZ Aurigae"
- Sohn, Y.-J., Kang, A., Rhee, J., Shin, M., Chun, M.-S., Kim, H.-I. 2006, A&A, "Near-IR photometry of asymptotic giant branch stars in the dwarf elliptical galaxy NGC 147"

(4) Jeon, Young-Beom (Principal Researcher)

Date hired: September 1, 1992

Highest degree attained: Ph. D.

Major: Variable stars, stellar photometry

Institution that conferred highest degree: Seoul National University

Key achievements:

- 31 research papers in SCI journals over the past 11 years
- Discovery of hundreds of new variable stars in open clusters
- Discovery of tens of new variable stars in globular clusters
- Discovery of 120 new asteroids and designated 12 Korean names

Career:

- February, 2003: Award of Ph.D.
- September 1, 1992 - present: Researcher at KASI

Representative published papers:

- Nemec, J. M., Walker, A., Jeon, Y.-B. 2009, AJ, "Variable Stars in the Large Magellanic Cloud Globular Cluster NGC 2257. I. Results Based on 2007-2008 B, V Photometry"
- Zharikov, S. V. et al. 2008, A&A, "Cyclic brightening in the short-period WZ Sge-type cataclysmic variable SDSS J080434.20+510349.2"
- Darnley, M. J. et al. 2007, ApJ, "The Angstrom Project Alert System: Real-Time Detection of Extragalactic Microlensing"
- Kim, C., Jeon, Y.-B., Kim, S.-L., Yushchenko, A. V. 2007, Astronomy Report, "Photometric study of an SX Phoenicis variable in the galactic halo"
- Jeon, Y.-B., Kim, S.-L., Lee, M. G., Lee, Ho, Lee, J. W. 2006, ApJ, "Discovery of an SX Phoenicis Type Pulsating Component in the Algol-Type Semidetached Eclipsing Binary QU Sagittae in M71"

(5) Lee, Jae Woo (Senior Researcher)

Date hired: July 1, 2007

Highest degree attained: Ph. D.

Major: Eclipsing binaries, extra-solar planets (transiting, timing)

Institution that conferred highest degree: Chungbuk National University (CNU)

Key achievements:

- 20 research papers in SCI journals over the past seven years
- Discovery of the first circum-binary planets by the eclipsing timing method
- Discovery of about ten multiple systems

Career:

- August 25, 2005: Award of Ph.D.
- March 2, 2001 - February 28, 2005: Part-time lecturer at CNU
- December 15, 2005 - September 30, 2006: Post-doctoral research at Sejong University
- October 1, 2006 - June 30, 2007: Post-doctoral research at KASI
- July 1, 2007 - present: Researcher at KASI
- March 1, 2010 - present: Professor at University of Science and Technology (UST)

Representative published papers:

- Lee, J. W., Kim, S.-L., Lee, C.-U., & Youn, J.-H. 2009, PASP, "The Solar-Type Contact Binary BX Pegasi Revisited"
- Lee, J. W., Youn, J.-H., Lee, C.-U., Kim, S.-L., & Koch, R. H. 2009, AJ, "The Period Variation of and a Spot Model for the Eclipsing Binary AR Bootis"
- Lee, J. W., Kim, S.-L., Lee, C.-U., Kim, H.-I., Park, J.-H., Park, S.-R., & Koch, R. H. 2009, PASP, "Photometric Properties of the Near-Contact Binary GW"
- Lee, J. W., Kim, S.-L., Kim, C.-H., Koch, R. H., Lee, C.-U., Kim, H.-I., Park, J.-H. 2009, AJ, "The sdB+M Eclipsing System HW Virginis and its Circumbinary"
- Lee, J. W., Youn, J.-H., Kim, C.-H., Lee, C.-U., Kim, H.-I. 2008, AJ, "a Photometric Study of the Short-Period Close Binary V432 Persei and its Implications for the Star's Evolution"

(6) Lee, Chung-Uk (Senior Researcher)

Date hired: August 1, 2003

Highest degree attained: Ph. D.

Major: Variable stars, stellar photometry, stellar spectroscopy

Institution that conferred highest degree: Chungbuk National University

Key achievements:

- 45 research papers in SCI journals over the past ten years
- Discovery of several extra-solar planets by the microlensing technique
- Discovery of a double-eclipsing binary system
- Participation in two international collaborations, WEBT and MicroFUN

Career:

- February 25, 2009: Award of Ph.D.
- August 1, 2003 - present: Researcher at KASI
- March 1, 2010 - present: Assistant professor at University of Science and Technology (UST)

Representative published papers:

- Raiteri, C. M, et al. 2009, A&A, "WEBT multiwavelength monitoring and XMM-Newton observations of BL Lacertae in 2007-2008. Unveiling different emission components"
- Lee, C.-U., Kim, S.-L., Lee, J. W., Kim, C.-H., Jeon, Y.-B., Kim, H.-I., Yoon, J.-N., & Humphrey, A. 2008, MNRAS, "V994 Herculis: the multiple system with a quadruple-lined spectrum and a double eclipsing feature"
- Gaudi, B. S., et al. 2008, Science, "Discovery of a Jupiter/Saturn Analog with Gravitational Microlensing"
- Lee, D.-W., Lee, C.-U., Park, B.-G., Chung, S.-J., Kim, Y.-S., Kim, H.-I., & Han, C. 2008, ApJ, "Microlensing Detections of Planets in Binary Stellar Systems"
- Lee, C.-U., & Lee, J. W. 2006, Journal of Korean Astronomical Society, "Photometric Study of the Near-Contact Binary CN Andromedae"

(7) Chung, Sun-Ju (Post-Doctoral)

Date hired: January 1, 2009

Highest degree attained: Ph. D.

Major: Microlensing

Institution that conferred highest degree: Chungbuk National University

Key achievements:

- Four research papers in SCI journals over the past two years

Career:

- February 25, 2008: Award of Ph.D.
- March 1 - December 31, 2008 : Assistant researcher at KASI
- January 1, 2009 - present: Post-doctoral research at KASI

Representative published papers:

- Chung, S.-J. 2009, ApJ, "Characterization of the Resonant Caustic Perturbation"
- Chung, S.-J., Park, B.-G., Ryu, Y.-H., Humphrey, A. 2009, ApJ, "A New Application of the Astrometric Method to Break Severe Degeneracies in Binary Microlensing Events"
- Chung, S.-J., Kim, D., Darnley, M. J., Duke, J. P., Gould, A., Han, C., Jeon, Y.-B., Kerins, E., Newsam, A., Park, B.-G. 2006, ApJ, "The Possibility of Detecting Planets in the Andromeda Galaxy"
- Chung, S.-J., Han, C., Park, B.-G. et al. 2005, ApJ, "Properties of Central Caustics in Planetary Microlensing"

Appendix 2 Key Research Achievements of the Extra-Solar Planet Research Group over the past five years

International Journal/Conference Papers				
No.	Year	Title	Journal/Conf.	Author
1	2009	The pulsating hot subdwarf Balloon 090100001: results of the 2005 multisite campaign	MNRAS	Baran, A. Oreiro, R. Kim, S.-L.(9/31)
2	2009	The sdB+M Eclipsing System HW Virginis and its Circumbinary Planets	AJ	Lee, J. W.(1/7) Kim, S.-L. Kim, C.-H.
3	2009	Photometric Properties of the Near-contact Binary GW Geminorum	PASP	Lee, J. W.(1/7) Kim, S.-L. Lee, C.-U.
4	2009	2006 Whole Earth Telescope Observations of GD358: A New Look at the Prototype DBV	ApJ	Provencal, J. L. Montgomery, M. H. Kim, S.-L.(23/55)
5	2009	A New Application of the Astrometric Method to Break Severe Degeneracies in Binary Microlensing Events	ApJ	Chung, S.-J.(1/4) Park, B.-G. Ryu, Y.-H.
6	2009	OGLE-2005-BLG-071Lb, the Most Massive M Dwarf Planetary Companion?	ApJ	Dong, S. Gould, A. Park, B.-G.(24/88)
7	2009	The Extreme Microlensing Event OGLE-2007-BLG-224: Terrestrial Parallax Observation of a Thick-Disk Brown Dwarf	ApJ	Gould, A. Udalski, A. Lee, C.-U.(22/78)
8	2009	Microlensing Event MOA-2007-BLG-400: Exhuming the Buried Signature of a Cool, Jovian-Mass Planet	ApJ	Dong, S. Bond, I Lee, C.-U.(42/61)
9	2009	The Period Variation of and a Spot Model for the Eclipsing Binary AR Bootis	AJ	Lee, J. W.(1/5) Youn, J.-H. Lee, C.-U.
10	2009	Extreme Magnification Microlensing Event OGLE-2008-BLG-279: Strong Limits	ApJ	Yee, J. C. Udalski, A. Lee, C.-U.(33/89)

No.	Year	Title	Journal/Conf.	Author
11	2009	Variable Stars in the LMC Globular Cluster NGC 2257. I. Results Based on 2007-2008 B,V Photometry	AJ	Nemec, J. M. Walker, A. Jeon, Y.-B.(3/3)
12	2009	Characterization of the Resonant Caustic Perturbation	ApJ	Chung, S.-J.(1/1).
13	2009	Interpretation of Strong Short-Term Central Perturbations in the Light Curves of Moderate-Magnification Microlensing Events	ApJ	Han, C. Hwang, K.-H. Lee, C.-U.(51/94)
14	2009	WEBT multiwavelength monitoring and XMM-Newton observations of BL Lacertae in 2007-2008	A&A	Raiteri, C. M. Villata, M. Lee, C.-U.(/69)
15	2009	The Solar-Type Contact Binary BX Pegasi Revisited	PASP	Lee, J. W.(1/4) Kim, S.-L. Lee, C.-U.
16	2009	Mass measurement of a single unseen star and planetary detection efficiency for OGLE 2007-BLG-050	A&A	Batista, V. Dong, S. Lee, C.-U.(15/100)
17	2008	The pulsation modes of the pre-white dwarf PG1159-035	A&A	Costa, J. E. S. Kepler, S. O. Kim, S.-L.(46/78)
18	2008	Discovery of a Jupiter/Saturn analog with gravitational microlensin	Science	Gaudi, B. S. Bennette, D. P. Lee, C.-U.(22/69)
19	2008	Radio-to-uv monitoring of AO 0235+164 by the WEBT and swift during the 2006–2007 outburst	A&A	Raiteri, C. M. Villata, M. Lee, C.-U.(36/61)
20	2008	A photometric study of the short-period close binary V432 Persei and its implications for the star evolution	AJ	Lee, J. W.(1/5) Youn, J.-H. Kim, C.-H.
21	2008	Color-shift measurement in microlensing-induced stellar variation from future space-based surveys	ApJ	Park, B.-G.(1/2) Han, C.
22	2008	RACE-OC project: rotation and variability in the open cluster NGC 2099 (M 37)	A&A	Messina, S. Distefano, E. Kim, S.-L.(5/7)
23	2008	A Long-term photometric study of the near-contact binary RU Ursae Minoris	PASP	Lee, J. W.(1/6) Kim, C.-H. Kim, S.-L.



No.	Year	Title	Journal/Conf.	Author
24	2008	The high activity of 3C 454.3 in autumn 2007. Monitoring by the WEBT during the AGILE detection	A&A	Raiteri, C. M. Villata, M. Lee, C.-U.(33/61)
25	2008	Cyclic brightening in the short-period WZ Sge-type cataclysmic variable SDSS J080434.20+510349.2	A&A	Zharikov, S. V. Tovmassian, G. H. Jeon, Y.-B.(9/11)
26	2008	V994 Herculis: the multiple system with a quadruple-lined spectrum and a double eclipsing feature	MNRAS	Lee, C.-U.(1/8) Kim, S.-L. Lee, J.-W.
27	2008	Absolute dimensions and apsidal motion of the eccentric binary V731 Cephei	MNRAS	Bakis, V. Zejda, M. Lee, J. W.(8/10)
28	2008	Limits of binaries that can be characterized by gravitational microlensing	ApJ	Kim, D. Ryu, Y.-H. Park, B.-G.(3/8)
29	2008	Results of WEBT, VLBA and RXTE monitoring of 3C279 during 2006-2007	A&A	Larionov, V. M. Jorstad, S. G. Lee, C.-U.(46/71)
30	2008	A new activity phase of the blazar 3C 454.3. Multifrequency observations by the WEBT and XMM-Newton in 2007-2008	A&A	Raiteri, C. M. Villata, M. Lee, C.-U.(12/75)
31	2007	Variable stars in the open cluster NGC 2099 (M37)	PASP	Kang, Y.B. Kim, S.-L.(2/7) Rey, S.-C.
32	2007	The radio delay of the exceptional 3C 454.3 outburst. Follow-up WEBT observations in 2005-2006	A&A	Villata, M. Raiteri, C. M. Lee, C.-U.(9/48)
33	2007	Asteroseismology of the PG 1159 star PG 0122+200	A&A	Fu, J.-N. Vauclair, G. Kim, S.-L.(7/26)
34	2007	The Angstrom project alert system: Real-time detection of extragalactic microlensing	ApJ	Darnler, M. J. Kerins, E. Jeon, Y.-B.(9/12)
35	2007	Multisite campaign on the open cluster M67 - II. Evidence for solar-like oscillations in red giant stars	MNRAS	Stello, D. Bruntt, H. Kim, S.-L.(8/22)
36	2007	Multisite campaign on the open cluster M67 - III. δ Scuti pulsations in the blue stragglers	MNRAS	Bruntt, H. Stello, D. Kim, S.-L.(15/23)

No.	Year	Title	Journal/Conf.	Author
37	2007	Follow-up observations of pulsating subdwarf B stars: Multisite campaigns on PG 1618+563B and PG 0048+091	ApJ	Reed, M. D. O'Toole, S. J. Kim, S.-L.(16/19)
38	2007	Photometric study of an SX Phoenicis variable in the galactic halo	Astronomy Reports	Kim, C. Jeon, Y.-B.(2/4) Kim, S.-L.
39	2007	A period study and light-curve synthesis for the Algol-type semidetached binary XX Cephei	MNRAS	Lee, J. W.(1/3) Kim, C.-H. Koch, R. H.
40	2007	Detection of M31 binaries via high-cadence pixel-lensing surveys	ApJ	Kim, D. Chung, S.-J. Jeon, Y.-B.(9/14)
41	2007	Chemical composition and differential time-series CCD photometry of V2314 Ophiuchi: A new λ Bootis-type star	AJ	Kim, C. Yushchenko, A. V. Kim, S.-L.(6/9)
42	2007	WEBT and XMM-Newton observations of 3C 454.3 during the post-outburst phase. Detection of the little and big blue bumps	A&A	Raiteri, C. M. Villata, M. Lee, C.-U.(44/76)
43	2007	A period study and spot model for the eclipsing binary TU Bootis	PASP	Lee, J. W.(1/3) Kim, H.-I. Kim, S.-L.
44	2007	Variable stars in the open cluster M11 (NGC 6705)	PASP	Koo, J.-R. Kim, S.-L.(2/7) Rey, S.-C.
45	2007	A study on the O-C diagram and pulsation behavior of KZ Hydra	Ap&SS	Kim, C. Kim, S.-L.(2/4) Kim, C.-H.
46	2007	The WEBT campaign on the blazar 3C 279 in 2006	ApJ	Bottcher, M. Basu, S. Lee, C.-U.(48/80)
47	2006	Near-IR photometry of asymptotic giant branch stars in the dwarf elliptical galaxy NGC 147	A&A	Sohn, Y.-J. Kang, A. Kim, H.-I.(6/6)
48	2006	Discovery of an SX Phoenicis Type Pulsating Component in the Algol-Type Semidetached Eclipsing Binary QU Sagittae in M71	ApJL	Jeon, Y.-B.(1/5) Kim, S.-L. Lee, M. G.

No.	Year	Title	Journal/Conf.	Author
49	2006	The Angstrom Project: a microlensing survey of the structure and composition of the bulge of the Andromeda galaxy	MNRAS	Kerins, E. Darnler, M. J. Jeon, Y.-B.(6/8)
50	2006	BVR observations and period variation of the near-contact binary ZZ Aurigae	MNRAS	Oh, K.-D. Kim, C.-H. Kim, H.-I.(4/5)
51	2006	Multi-colour optical monitoring of eight red blazars	A&A	Gu, M. F. Lee, C.-U.(2/5) Pak, S.
52	2006	A multisite photometric campaign on the pre-main-sequence Delta Scuti pulsator IP Persei	A&A	Ripepi, V. Bernabei, S. Kim, S.-L.(10/21)
53	2006	Planetary Detection Efficiency of the Magnification 3000 Microlensing Event OGLE-2004-BLG-343	AJ	Dong, S. DePoy, D. L. Park, B.-G.(6/15)
54	2006	Microlensing Sensitivity to Earth-Mass Planets in the Habitable Zone	AJ	Park, B.-G.(1/4) Jeon, Y.-B. Lee, C.-U.
55	2006	Microlens OGLE-2005-BLG-169 Implies that Cool Neptune-Like Planets are Common	AJ	Gould, A. Udalski, A. Park, B.-G.(18/36)
56	2006	The unprecedented optical outburst of the quasar 3C 454.3. The WEBT campaign of 2004-2005	ApJL	Villata, M. Raiteri, C. M. Lee, C.-U.(57/88)
57	2006	The pulsating subdwarf B star PG0014+067	ApJ	Vuckovic, M. Kawaler, S. D. Kim, S.-L.(18/44)
58	2006	The evolved asymptotic giant branch stars in the central bar of the dwarf irregular galaxy NGC 6822	A&A	Kang, A. Sohn, Y.-J. Kim, H.-I.(3/9)
59	2006	The Possibility of Detecting Planets in the Andromeda Galaxy	ApJ	Chung, S.-J. Kim, D. Jeon, Y.-B.(7/10)
60	2006	The pulsating subdwarf B star PG1325+101 I	A&A	Silvotti, R. Bonanno, A. Kim, S.-L.(11/28)

No.	Year	Title	Journal/Conf.	Author
61	2006	The pulsating subdwarf B star PG1325+101 II	A&A	Charpinet, S. Silvotti, R. Kim, S.-L.(15/28)
62	2006	Multifrequency variability of the blazar AO 0235+164 - The WEBT campaign in 2004-2005 and long-term SED analysis	A&A	Raiteri, C. M. Villata, M. Lee, C.-U.(60/61)
63	2006	Multi-site campaign on the open cluster M67. I. Observations and photometric reductions	MNRAS	Stello, D. Arentoft, T Kim, S.-L.(14/22)
64	2006	Deep near-IR photometry of eight metal-poor globular clusters in the Galactic bulge and halo	A&A	Kim, J.-W. Kang, A. Kim, H.-I.(4/10)
65	2006	Blending in future space-based microlensing surveys	ApJ	Han, C. Park, B.-G.(2/4) Kim, H.-I.
66	2006	A Search for Pulsating, Mass-Accreting Components in Algol-Type Eclipsing inaries	Ap&SS	Mkrtychian, D. Kim, S.-L.(2/12) Kusakin, A. V.
67	2005	An asteroseismic test of diffusion theory in white dwarfs	A&A	Metcalfe, T. S. Nather, R. E. Kim, S.-L.(4/6)
68	2005	Different Characteristics of the Bright Branches of the Globular Clusters M3 and M13	AJ	Cho, D.-H. Lee, S.-G. Jeon, Y.-B.(3/4)
69	2005	Near-IR photometry of asymptotic giant branch stars in the dwarf elliptical galaxy NGC 185	A&A	Kang, A. Sohn, Y.-J. Kim, H.-I.(6/6)
70	2005	A Jovian-Mass Planet in Microlensing Event OGLE-2005-BLG-071	ApJL	Udalski, A. Jaroszynski, M. Park, B.-G.(20/33)
71	2005	Properties of Central Caustics in Planetary Microlensing	ApJ	Chung, S.-J. Han, C. Park, B.-G.(3/12)
72	2005	Coordinated Multiwavelength Observation of 3C 66A during the WEBT Campaign of 2003-2004	ApJ	Bottcher, M. Harvey, J. Lee, C.-U.(70/72)
73	2005	Orbital and spin variability of the intermediate polar BG CMi	A&A	Kim, Y. G. Andronov, I. L. Jeon, Y.-B.(4/4)
74	2005	Photometric properties of the variable star LZ Her	PASP	Kim, S.-L.(1/6) Lee, J.-W. Kim, C.

Appendix 3 Key Research Activities of the Extra-Solar Planet Research Group over the past five years

Domestic/International Seminars and Meetings				
No.	Year	Title	Main Contents.	No. of Participants (Countries)
1	2008	Optical Survey for Extra-solar Planets 	A total of 16 paper (All oral presentation)	37 (4)
2	2007	Gravitation Microlensing Workshop 	A total of 46 papers (36 oral presentation, ten posters)	74 (9)

Appendix 4 Key Researchers in the Solar Physics and Space Weather Research Group

(1) Park, Young-deuk (Principal Researcher)

Date hired: 1990-12-01

Highest degree attained: Ph.D.

Major: Solar physics

Institution that conferred highest degree: Seoul National University

Key achievements:

- Construction of Solar flare telescope, Coelostat spectrograph.
- 9 times of total solar eclipse expedition since 1991.
- Development FISS for New Solar Telescope in BBSO
- Establishment of Korean Space Weather Center
- SCI paper publication
- : 2 (First Author), 54 (Coauthor)

Career :

- Team leader of Solar Activity Research Team (1994 – 2003)
- Visiting scientist at BBSO (2004)
- Head of Space Science research department (July 2005 – February 2007)
- Vice-President of KASI (March 2007 – July 2008)
- Chairman of the Space Environment Committee in the Korean Astronomy Society (August 2002. - present)
- Board Director of Korean Space Science Society (January 2007 – December 2009)

(2) Cho, KyungSuk (Senior Researcher)

Date hired: 2002-12-01

Highest degree attained: PhD

Major: Solar physics

Institution that conferred highest degree: KyungHee University

Key achievements:

- Origin of Solar Type II radio burst
- Early eruption of CMEs and their geo-effectiveness
- Imaging spectroscopic study of small pores using HINODE
- SCI paper publication: seven (first author), 36 (co-author)

Career :

- Researcher at the Radio Research Laboratory (1996 – 2002)
- Visiting scientist at NJIT (2006)
- Head of Solar and Space weather group (September 2007 – February 2010)
- Endowed Professor at Chungbuk National University (2007)
- Endowed Professor at University of Science & Technology (2008 ~)

(3) Kim, Yeon-Han (Senior Researcher)

Date hired: 2004-07-01

Highest degree attained: PhD

Major: Solar physics

Institution that conferred highest degree: KyungHee University

Key achievements:

- CME and flare association of X-ray plasma ejection
- Relationship between X-ray plasma ejection, coronal mass ejection, and type II radio

burst

- Wave propagation in the spicule observed by the Hinode SOT
- SCI paper publication

: 5 (First Author), 18(Coauthor)

Career :

- Post Doc. Researcher (2003. 9 – 2004.6)
- Head of Solar & Space weather group (2010. 3 –)
- Endowed Professor of University of Science & Technology (2008 -)

(4) Choi, Seonghwan (Senior Engineer)

Date hired: 2004-11-01

Highest degree attained: M.S.

Major: Solar physics

Institution that conferred highest degree: Kyunghee University

Key achievements:

- Construction of Space Weather Prediction Center (2007 ~)
- Development of Solar Full-Disk Monitoring System, Ministry of Science and Technology (MOST) (2004~2005)
- Constructing Database System of Ocean Data, Daemyung Data System, Inc., Rep. of Korea Navy (1998)

Career :

- Software Engineer, Korea Astronomy and Space Science Institute (2004. 10. ~)
- Technical Director, Hinet Advanced Technology and Information, Inc. (1998. 10. ~ 2004. 9.)
- Research Engineer, Daemyung Data System, Inc. (1998. 2. ~ 1998. 9.)

(5) Bong, Su-Chan (Senior Researcher)

Date hired: 2006-12-01

Highest degree attained: PhD

Major: Solar Physics

Institution that conferred highest degree: Seoul National University

Key achievements:

- Development of Spatio-Spectral Maximum Entropy Method for Owens Valley Solar Array
- Development of MEMNJIT for Reuven Ramaty High Energy Solar Spectroscopic Imager
- Discovery of magnetic breakout during Coronal Mass Ejection initiation
- Construction of the solar radio observing facilities (e-CALLISTO and Korean Solar Radio Burst Locator) of the Korea Astronomy and Space Science Institute
- SCI paper publication
2 (first author), 16 (coauthor)

Career :

- Post-doctoral Researcher, Korea Astronomy and Space Science Institute (2004.9 – 2006.11)
- Senior Researcher, Korea Astronomy and Space Science Institute (2006.12 -)
- Adjunct Professor, University of Science and Technology (2008.3 -)

(6) Kwak, Young-Sil (Senior Researcher)

Date hired: 2007-12-01

Highest degree attained: PhD

Major: Ionosphere/ Upper atmosphere

Institution that conferred highest degree: Kyungpook National University

Key achievements:

- Electro-dynamical characteristics of the polar ionosphere based on the incoherent scatter radar
- Analysis of momentum forcing in the thermosphere by using NCAR-TIEGCM
- Dependence of thermospheric density on the interplanetary magnetic field
- Ionospheric irregularities based on the VHF coherent scatter radar
- Paper publications (2005-current)

SCI paper : 4 (First author), 4 (coauthor)

Non-SCI paper : 3 (First author), 3 (coauthor)

Career :

- Visiting Scientist, NCAR/HAO, USA (2002~2004)
- Postdoctoral Fellow, NCAR/HAO, USA (2005~2007)
- Senior Research Scientist, KASI, Korea (2007~)
- Endowed Professor of University of Technology & Science (2008~)

(7) Hwang, Junga (Senior Researcher)

Date hired: 2007-12-01

Highest degree attained: PhD

Major: Space Physics

Institution that conferred highest degree: KAIST (Korea Advanced Institute Science and Technology)

Key achievements:

- Developing Space Physics Payloads for STSAT-1
 - Seed particles of Radiation Belt in the outer magnetosphere
 - Wave-particle interaction in radiation belt
 - Solar Energetic Particles and Corona Mass Ejection
 - SCI paper publication
- : 4 (First Author), 6 (Coauthor)

Career :

- Satellite Research Center (2000-2003)
- Physical Science Research Center (2006)
- Korea Astronomy and Space Science (2007-)

(8) Lee, Jaejin (Senior Researcher)

Date hired: 2007-12-21

Highest degree attained: PhD

Major: Space Physics

Institution that conferred highest degree: KAIST (Korea Advanced Institute Science and Technology)

Key achievements:

- Development of SPP (Space Physics Package) for KAISTSAT-1
- Development of KOMPSAT (Korea Multi-Purpose Satellite)-1 payload
- Development of sounding rocket, KSR-II payload

Career :

- PostDoc at KAIST (2002.3 – 2004.2)
- PostDoc at UC Berkeley (2004. 3 – 2006. 9)
- Senior Researcher at Satellite Technology Research Center (2006. 10 – 2007. 12)

Appendix 5 Key Research Achievements of the Solar Physics and Space Weather Research Group

International Journal/Conference Papers				
No.	Year	Title	Journal/Conf	Author
1	2005	A study of flare-associated X-ray plasma ejections I. Association with CMEs (ApJ 622, 1240)	The Astrophysical Journal	Y.-H. Kim, Y.-J. Moon, K.-S. Cho, K.-S. Kim, Y.-D. Park
2	2005	New geoeffective parameters of very fast halo coronal mass ejections (ApJ 624, 414)	The Astrophysical Journal	Y.-J. Moon, K.-S. Cho, M. Dryer, Y.-H. Kim, S.-C. Bong, J.-C. Chae, Y.-D. Park
3	2005	The Magnetic Structure of Filament Barbs (ApJ 626, 574)	The Astrophysical Journal	J.-C. Chae, Y.-J. Moon, Y.-D. Park
4	2005	Solar-Cycle Variation of Magnetic Helicity in Active Region (Publ. Astron. Soc. Japan(PASJ), 57, 481)	Publ. Astron. Soc. Japan(PASJ)	Hakino, Sakurai, T.
5	2005	New Extrapolation Method For CME Onset Time Estimation (JGR 110, A7, 10.1029/2005JA011098)	Journal of Geophysical Research	Y.-J. Moon, K.-S. Cho, J.-C. Chae, K.-S. Choi, Y.-H. Kim, S.-C. Bong, Y.-D. Park
6	2005	Magnetic Twist of an EUV Coronal Loop Inferred from Plasma Constriction (ApJ 629, 1110)	The Astrophysical Journal	J.-C. Chae, Y.-J. Moon
7	2005	A new perspective on the role of the solar wind dynamic pressure in the ring current particle loss through the magnetopause (JGR 110, A09223, doi:10.1029/2005JA011097)	Journal of Geophysical Research	K.-C. Kim, D.-Y. Lee, E.-S. Lee, J.-L. Choi, K.-H. Kim, Y.-J. Moon, K.-S. Cho, Y.-D. Park, and W. Y. Han
8	2005	Pi2 pulsations observed from the Polar satellite outside the plasmopause (GRL 32, doi:10.1029/2005GL023872)	GRL	K.-H. Kim, D.-H. Lee, K. Takahashi, C. T. Russell, Y.-J. Moon, and K. Yumoto

No.	Year	Title	Journal/Conf	Author
9	2005	Pi2 pulsations in a small and strongly asymmetric plasmasphere (JGR 110, A10201, doi:10.1029/2005JA011179)	Journal of Geophysical Research	K.-H. Kim, D.-H. Lee, R. Denton, K. Takahashi, J. Goldstein, Y.-J. Moon, K. Yumoto, Y.-S. Pyo, and A. Keiling
10	2005	Multiple Type II solar radio bursts (Solar Physics 232, 87)	Solar Physics	Shanmugaraju, Y.-J. Moon, K.-S. Cho, Y.-H. Kim, M. Dryer, Umapathy
11	2005	A Study of flare-associated X-ray plasma ejections III. Kinematic properties (ApJ 635, 1291)	The Astrophysical Journal	Y.-H. Kim, Y.-J. Moon, K.-S. Cho, S.-C. Bong, Y.-D. Park
12	2005	Forecast evaluation of the CME geoeffectiveness using halo CMEs from 1997 to 2003	Journal of Geophysical Research	R.-S. Kim, K.-S. Cho, Y.-J. Moon, Y.-H. Kim, Yu Yi, M. Dryer, S.-C. Bong, Y.-D. Park
13	2005	Examination of Type II Origin with SOHO/LASCO Observations (JGR doi:10.1029/2004JA010744)	Journal of Geophysical Research	K.-S. Cho, Y.-J. Moon, M. Dryer, A. Shanmugaraju, C. D. Fry, Y.-H. Kim, S.-C. Bong, Y.-D. Park
14	2006	Direct Observation of Low Coronal Breakout: Does Breakout Precede or Follow Solar Eruption? (ApJ 636, 169-172)	The Astrophysical Journal	S.-C. Bong, Y.-J. Moon, K.-S. Cho, Y.-H. Kim, Y.-D. Park, K.-S. Choi
15	2006	Spatio-Spectral Maximum Entropy Method: I. Formulation and Test (ApJ 636, 1159-1165)	The Astrophysical Journal	S.-C. Bong, J.-W. Lee, D. E. Gary, H.-S. Yoon
16	2006	Origin of coronal shocks without mass ejections (Solar Physics 233, 117-127)	Solar Physics	Shanmugaraju, Y.-J. Moon, K.-S. Cho, M. Dryer, Umapathy
17	2006	Imaging Spectroscopy of a Solar Filament Using a Tunable H α Filter (Solar Physics, 234, 115-134)	Solar Physics	J.-C. Chae, Y.-D. Park, H.-M. Park
18	2006	Coronal mass ejection geoeffectiveness depending on field orientation and interplanetary coronal mass ejection classification (JGR, 111, A05102, doi:10.1029/2005JA011445)	Journal of Geophysical Research	S.-M. Kang, Y.-J. Moon, K.-S. Cho, Y.-H. Kim, Y.-D. Park, J.-H. Baek, H.-Y. Chang

No.	Year	Title	Journal/Conf	Author
19	2006	Atmospheric drag effects on the KOMPSAT-1 satellite during geomagnetic superstorms (Earth Planets Space, 58, e25-e28)	Earth Planets Space	K.-H. Kim, Y.-J. Moon, K.-S. Cho, H.-D. Kim, Jinyoung Park
20	2006	Simultaneous ground-based and satellite observations of Pc5 geomagnetic pulsations: A case study using multipoint measurements (Earth Planets Space, 58, 873-883)	Earth Planets Space	S.-K. Sung, K.-H. Kim, D.-H. Lee, K. Takahashi, C. A. Cattell, M. Andre, Y. V. Khotyaintsev, A. Balogh
21	2006	An Overview of existing algorithms for resolving the 180 ambiguity in vector magnetic fields: Quantitative tests with synthetic data (Solar Physics, 10.1007/s11207-006-0170-x)	Solar Physics	Metcalf, Thomas R., Leka, K. D., Barnes, Graham, Lites, Bruce W., Georgoulis, Manolis K., Pevtsov, A. A., Balasubramaniam, K. S., Gary, G. Allen, Jing, Ju, Li, Jing, Liu, Y., Wang, H. N., Abramenko, Valentyna, Yurchyshyn, Vasyl, Moon, Y.-J.
22	2006	Calibration of TRACE Lyman- α images using SOHO/SUMER observations (A&A, 456, 747-750)	Astronomy and Astrophysics	S.-S. Kim, Hee Seon Roh, K.-S. Cho, J.-H. Shin
23	2006	X-ray plasma ejections associated with coronal type II shocks (A&A, 458, 653-659)	Astronomy and Astrophysics	Shanmugaraju, Y.-J. Moon, Y.-H. Kim, K.-S. Cho, M. Dryer, Umapathy
24	2006	Repetitive substorms caused by Alfvénic waves of the interplanetary magnetic field during high-speed solar wind streams (JGR, 111, A12214, doi:10.1029/2006JA011685)	Journal of Geophysical Research	D.-Y. Lee, L.R. Lyons, K.-C. Kim, J.-H. Baek, K.-H. Kim, H.-J. Kim, J. Weygand, Y.-J. Moon, K.-S. Cho, Y.-D. Park
25	2007	A Study of CME and Type II Shock Kinematics Based on Coronal Density Measurement (A&A, 461, 1121-1125)	Astronomy and Astrophysics	K.-S. Cho, J.-W. Lee, Y.-J. Moon, M. Dryer, S.-C. Bong, Y.-H. Kim, Y.-D. Park
26	2007	A check for consistency between different magnetic helicity measurements based on the helicity conservation principle (ApJ, 656, 1167-1172)	The Astrophysical Journal	E.-K. Lim, H.-W. Chung, J.-C. Chae, Y.-J. Moon

No.	Year	Title	Journal/Conf	Author
27	2007	Prediction of the 1-AU arrival times of CME-associated interplanetary shocks: Evaluation of an empirical interplanetary shock propagation model (JGR, 112, doi:10.1029/2006JA011904)	Journal of Geophysical Research	K.-H. Kim, Y.-J. Moon, K.-S. Cho
28	2007	Analysis of RHESSI Flares Using aRadio Astronomical Technique(SOLAR PHYSICS, 240, 241 - 252)	Solar Physics	E. J. Schmahl, R. L. Pernak, G. J. Hurford, J. Lee, S.-C. Bong
29	2007	Plasmaspheric drainage plume observed by the Polar satellite in the prenoon sector and the IMAGE satellite during the magnetic storm of 11 April 2001(JGR, 112, A06237)	Journal of Geophysical Research	K.-H. Kim, J.Goldstein, D. Berube
30	2007	Multi_Wavelength Signatures of Magnetic Reconnection of a Flare-Associated Coronal Mass Ejection(Solar Physics, 242, 143-158)	Solar Physics	Bhuwan Joshi, P.K. Manoharan, Astrid M. Veronig, P.Pant, Kavita Pandey
31	2007	Magnetic Field Strength in the Solar Corona from Type II Band Splitting (APJ, 665, 799 - 804)	The Astrophysical Journal	K.-S. Cho, J.-W. Lee, D.-E. Gary, Y.-J. Moon, Y.-D. Park
32	2007	Statistical significance of association between whistler-mode chorus enhancements and enhanced convection periods during high-speed streams (JGR, 112, A09213, doi:10.1029/2007JA012388)	Journal of Geophysical Research	Junga Hwang, D.-Y. Lee, L.R. Lyons, A.J. Smith, S. Zou, K.-U. Min, K.-H. Kim, Y.-J. Moon, Y.-D. Park
33	2007	Statistical analysis of the relationship between Earthward flow bursts in the magnetotail and low-latitude Pi2 pulsations (JGR, 112, A10211)	Journal of Geophysical Research	K.-H. Kim, K. Takahashi, S. Ohtani, S.-K. Sung
34	2007	The Eruption from a Sigmoidal Solar Active Region on 2005 May 13(APJ,669.1372-1381)	The Astrophysical Journal	Liu. Chang, J.-W. Lee, Yurchyshyn. Vasyl, Deng. Na, K.-S. Cho, Karlicky. Marian, Wang. Haimin

No.	Year	Title	Journal/Conf	Author
35	2007	Two-Step Reconnections in a C3.3 Flare and Its Preflare Activity Observed by Hinode XRT (PASJ, Vol.59, Hinode Special Issue)	Publ. Astron. Soc. Japan(PASJ)	Sujin kim, Y.-J. Moon, Y.-H. Kim, T. Sakurai, J.-C. Chae, K.-S. Kim, K.-S. Choi
36	2007	Small-scale X-ray/EUV Jets seen in Hinode XRT and TRACE (PASJ, 59,s763-s769)	Publ. Astron. Soc. Japan(PASJ)	Y.-H. Kim, Y.-J. Moon, Y.-D. Park, T.Sakurai, J.-C. Chae, K.-S. Cho, S.-C. Bong
37	2007	Hinode SP vector magnetogram of AR 10930 and its cross-ameparison with MDI (PASJ,59,S625-S630)	Publ. Astron. Soc. Japan(PASJ)	Y.-J. Moon, Y.-H. Kim, Y.-D. Park, K. Ichimoto, T. Sakurai, J.-C. Chae, K.-S. Cho, S.-C. Bong, Y. Suematsu, S. Tsuneta, Y. Katsukawa, M. Shimojo, T. Shimizu, R. Shine, T. Tarbell, A. Title, B. Lites, M. Kubo, S. Nagata, T. Yokoyama
38	2007	Long-duration magnetic clouds: a comparison of analyses using torus- and cylinder-shaped flux rope models (Ann. Geophys, 25, 2453-2477)	Ann. Geophys	K. Marubashi, R. P. Lepping
39	2007	Initial results in line-of-sight field calibrations of SP/NFI data taken by SOT/HINODE (PASJ, 59, s619 ~ s624)	Publ. Astron. Soc. Japan(PASJ)	J.-C. Chae, Y.-J. Moon, Y.-D. Park, K. Ichimoto, T. Sakurai, Y. Suematsu, S. Tsuneta, Y. katsukawa, Toshifumi Shimizu, Richard A. Shine, Theodore D. Tarbell, Alan M. Title, Bruce Lites, Masahito Kubo, Shin'ichi Nagata, Takaaki Yokoyama
40	2008	CME earthward direction as an important geoeffectiveness indicator	The Astrophysical Journal	Kim, R.-S., Cho, K.-S., Kim, K.-H., Park, Y.-D., Moon, Y.-J., Yi, Y., Lee, J., Wang, H., Song, H., Dryer, M

No.	Year	Title	Journal/Conf	Author
41	2008	Investigation of CME dynamics in the LASCO field of view	Astronomy and Astrophysics	A. Shanmugaraju, Yong-Jae Moon, Kyung-Suk Cho, N. Gopalswamy, S. Umapathy
42	2008	Comparison between the KOMPSAT-1 drag derived density and the MSISE model density during strong solar and/or geomagnetic activities	Earth Planets Space	J. Park, Y.-J. Moon, K.-H. Kim, K.-S. Cho, H.-D. Kim, Y.-S. Kwak, Y.-H. Kim, Y.-D. Park, Y. Yi
43	2008	Preflare eruption triggered by a tether-cutting process	The Astrophysical Journal	Kim, S, Moon, Y.-J., Kim, Y.-H., Park, Y.-D., Kim, K.-S., Choe, G. S., Kim, K.-H.
44	2008	Comparison of SOHO UVCS and MLSO MK4 coronameter densities	Astronomy and Astrophysics	Lee, K. S., Moon, Y. J., Kim, K. S., Lee, J. Y., Cho K. S., Choe, G. S.
45	2008	Magnetic signatures and conjugate features of low-latitude plasma blobs as observed by the CHAMP satellite	Journal of Geophysical Research	Jaeheung Park, Claudia Stolle, Hermann Luhr, Martin Rother, Shin-Yi Su, Kyoung Wook Min, Jae-Jin Lee
46	2008	Equatorial plasma bubbles with enhanced ion and electron temperatures	Journal of Geophysical Research	Jaeheung Park, Kyoung Wook Min, Vitaly P. Kim, Hyosub Kil, Shin-Yi Su, Chi Kuang Chao, Jae-Jin Lee
47	2008	Reply to comment by N. Gopalswamy and H. Xie on "Prediction of the 1-AU arrival times of CME-associated interplanetary shocks: Evaluation of an empirical interplanetary shock propagation model"	Journal of Geophysical Research	K.-H. Kim, Y.-J. Moon, K.-S. Cho
48	2008	Low coronal observations of metric type II associated CMEs by MLSO coronameters	Astronomy and Astrophysics	K.-S. Cho, S.-C. Bong, Y.-H. Kim, Y.-J. Moon, M. Dryer, A. Shanmugaraju, J. Lee, and Y. D. Park

No.	Year	Title	Journal/Conf	Author
49	2009	A World-Wide Net of Solar Radio Spectrometers: e-CALLISTO	Earth, Moon, and Planets	Benz, A. O.; Monstein, C.; Meyer, H.; Manoharan, P. K.; Ramesh, R.; Altyntsev, A.; Lara, A.; Paez, J.; Cho, K.-S.
50	2009	Statistical Analysis of the Relationships among Coronal Holes, Corotating Interaction Regions, and Geomagnetic Storms	Solar Physics	Choi, Y., Moon, Y.-J., Choi, S., Baek, J.-H., Kim, S. S., Cho, K.-S., Choe, G. S.
51	2009	The 27-day modulation of the low-latitude ionosphere during a solar maximum	Journal of Geophysical Research	Kyoung Min, Jaeheung Park, Heejun Kim, Vitaly Kim, Hyosub Kil, Jaejin Lee, Stefanie Rentz, Hermann Lu ^{hr} , Larry Paxton
52	2009	Dependence of the High-Latitude Thermospheric Densities on the Interplanetary Magnetic Field	Journal of Geophysical Research	Y.-S. Kwak, A. D. Richmond, Y. Deng, J. M. Forbes, K.-H. Kim
53	2009	Impacts of torus model on studies of geometrical relationships between interplanetary magnetic clouds and their solar origins	Earth Planets Space	Katsuhide Marubashi, Suk-Kyung Sung, Kyung-suk Cho, Ronald P. Lepping
54	2009	The Korean Solar Radio Burst Location (KSRBL)	Publications of the Astronomical Society of the Pacific	Yujiang Dou, Dale E. Gary, Zhiwei Liu, Gelu M. Nita, Su-Chan Bong, Kyung-Suk Cho, Young-Deuk Park, Yong-Jae Moon
55	2009	A Comparison of CME initial speeds with Magnetic flux and magnetic helicity of magnetic clouds	The Astrophysical Journal	S.-K. Sung, K. Marubashi, K.-H. Kim, K.-S. Cho, J. Chae, Y. Moon
56	2009	Reversed ionospheric convections during November 2004 storm: 1. Impact on the upper atmosphere	Journal of Geophysical Research	Yue Deng, Gang Lu, Young-Sil Kwak, Eric Sutton, Jeffrey Forbes, Stan Solomon

No.	Year	Title	Journal/Conf	Author
57	2009	Low Latitude E-region irregularities studied using Gadanki radar, ionosonde and insitu measured electron density	Astrophys Space Sci	D. V. Phani Kumar, A. K. Patra, Y.-S. Kwak, K.-H. Kim, G. Yellaiah
58	2009	Solar-wind-magnetosphere coupling, including relativistic electron energization, during high-speed streams	Journal of Atmospheric and Solar-Terrestrial Physics	L.R. Lyons, D.-Y. Lee, H.-J. Kim, J.A. Hwang, R.M. Thorne, R.B. Horne, A.J. Smith
59	2009	Global MHD simulation of the geomagnetic sudden commencement on October 21, 1999	Journal of Geophysical Research	K.-H. Kim, K. S. Park, T. Ogino, S.-K. Sung, Y.-S. Kwak
60	2009	A Coronal Mass Ejection and Hard X-ray Emissions Associated with the Kink Instability	The Astrophysical Journal	Kyung-Suk Cho, Jeongwoo Lee, Su-Chan Bong, Yeon-Han Kim, Bhuwan Joshi, Young-Deuk Park
61	2009	Intriguing aspects of F-region plasma irregularities revealed by the Gadanki radar observations during the SAFAR campaign	Annales Geophysicae	A. K. Patra, D. V. Phanikumar
62	2009	A study on the low-latitude daytime E region plasma irregularities using coordinated VHF radar, rocket-borne and ionosonde observations	Journal of Geophysical Research	A. K. Patra, N. Venkateswara Rao, D. V. Phani Kumar, H. Chandra, U. Das, H. S. S. Sinha, T. K. Pant, S. Sripathi
63	2009	On the relationship of cosmic ray intensity with solar, interplanetary, and geophysical parameters	Astrophysics and Space Science	K. A. Firoz, D. V. Phani Kumar, K.-S. Cho

Appendix 6 Key Research Activities of the Search for Solar Physics and Space Weather Research Group over the past five years

Domestic/International Seminars and Meetings				
No	Year	Title	Main Contents.	No. of Participants (Countries)
1	2007	Opening Meeting for Space Weather Monitoring Lab.	Introduction of SWML	65 (Korea)
2	2007	Korea-China Solar Physics Workshop	Solar physics and Space weather	54 (Korea, China, USA)
3	2007	Workshop on the feasibility study of Ionospheric observation system for Korean peninsula	The feasibility study of Ionospheric observation system for Korean peninsula	40 (Korea, USA)
4	2008	The First Korean Winter School on Space Physics	Sun and space weather	80 (Korea, USA, Brasil, UK, Canada, Japan, Germany)
5	2008	The Korea-Japan Space Weather Modeling Workshop 1. Earth's Magnetosphere and Ionosphere Model	Development of space weather model	25 (Korea, Japan)
6	2008	The Korea-Japan Space Weather Modeling Workshop 2. Application of the Space Weather Model	Development of space weather model	25 (Korea, Japan)
7	2008	The Korea-Japan Space Weather Modeling Workshop 3. Solar Eruption Model	Development of space weather model	25 (Korea, Japan)
8	2009	2009 UN BSS and IHY Workshop	sun, space weather, basic space science	300 (33countries)
9	2010	Opening meeting for the VHF coherent scatter radar	Introduction of VHF radar	40 (Korea)



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