한국천문연구원
Korea Astronomy & Space Science Institute

KASI INTRODUCTION

Korea Astronomy and Space Science Institute

April 25, 2016

Byeong-Gon Park

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I ABOUT KASI

Institute General

Vision

Exploring the knowledge of the Universe benefits the humankind.

Mission

- We are performing creative and challenging research.
- We are promoting research co-operations with active communication.
- We are contributing to the society, exploring the knowledge of the universe.

Institute General : History

1974 Foundation of Korea Astronomy Observatory (KAO) as the national observatory

1978 Sobaeksan Optical Astronomy Observatory (SOAO) was built on Mt. Sobaek

1985 Taeduk Radio Astronomy Observatory (TRAO) was built in Daejeon

1986 KAO was renamed as the Institute of Space Science and Astronomy (ISSA)

1992 The first Global Positioning System (GPS) Station of Korea was built in ISSA

1996 Bohyunsan Optical Astronomy Observatory (BOAO) was built on Mt. Bohyun

1999 ISSA became an independent organization as a government-funded research institute under the administration of KRCF (Korea Research Council of Fundamental Science and Technology)

2002 Solar Imaging Spectrograph Telescope was built in ISSA

2003 Lemmonsan Optical Astronomy Observatory (LOAO) was built on Mt. Lemmon, in Arizona, USA
The first Korean Space telescope FIMS (Far-ultraviolet Imaging Spectrograph) onboard STSAT-1

2004 ISSA was renamed as the Korea Astronomy and Space Science Institute (KASI)

2005 International Center for Astrophysics was established in KASI

2006 Space Geodesy Division was established and the International GNSS Service GDC(Global Data Center) started operation in KASI

2007 The Space Weather Monitoring Lab was established in KASI

2008 The construction of the Korea VLBI Network (KVN) was completed

2009 Data Center for Astronomical Almanac was appointed officially by the Ministry of Knowledge Economy
Participation in the GMT (Giant Magellan Telescope) project

2012 Korea-Japan VLBI Correlation Center open

2013 MIRIS, IGRINS, 4-Channel Observation of KVN, KVN+VERA, KMTNet, OWL, SLR

2015 Korea Microlensing Telescope Network (KMTNet) was established

Human Resources & Budget

● Human Resources (2016. 04.)

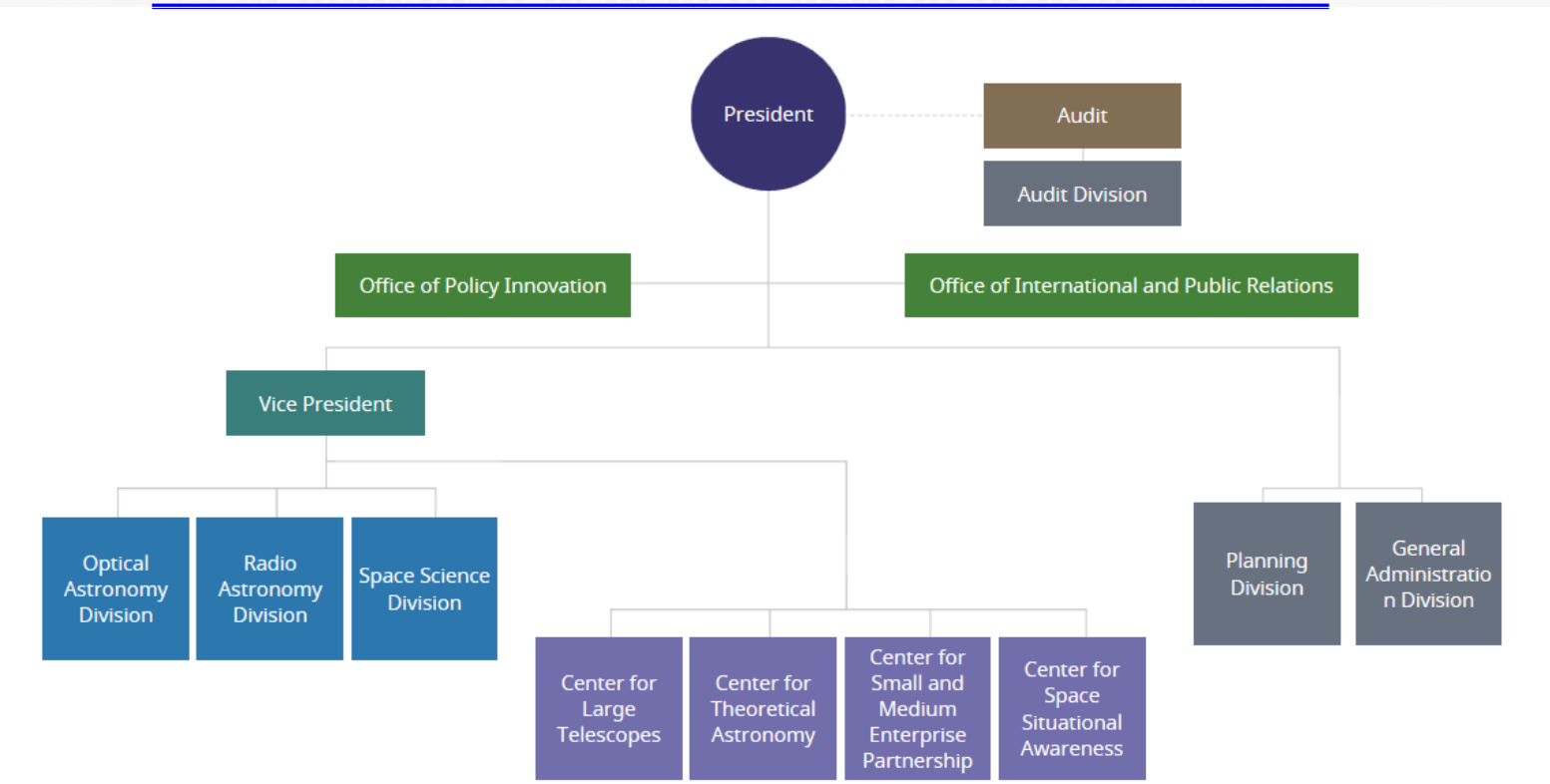
- Total Number of staffs	376
- Research Staffs	213 (25*) * foreign researchers
- Engineers & Technicians	23
- Administrative Staffs	82
- UST Students & Interns	58

● Budget FY2016

- Total	65 Million USD
- Research	43 Million USD

Organization

- **3 Divisions and 4 Centers**



II

FACILITIES

KASI Facilities

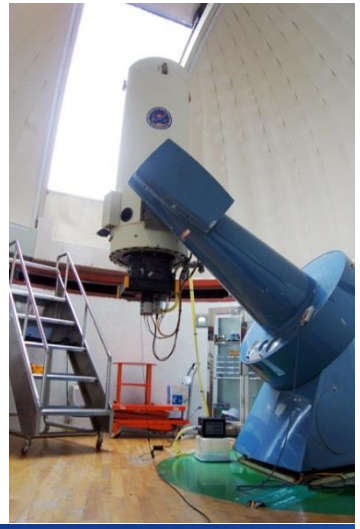
- **Domestic**

KASI Facilities

- **Overseas**

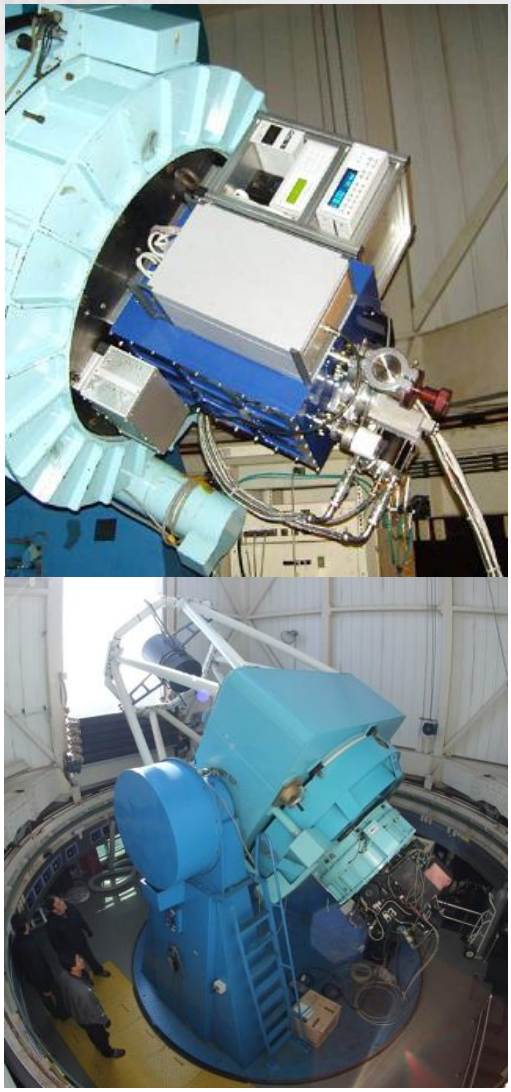
SOAO

- **Sobaeksan Optical Astronomy Observatory**
- **built in 1978**
- **a 61cm reflecting telescope**
- **Instrument**
  - 2K CCD camera
- **~10 observational research programs/year**
- **Main Researches Fields**
  - Variable stars
  - Transits of extra-solar planets
  - AGNs, GRBs
- **Education programs**
- **Public outreach programs**



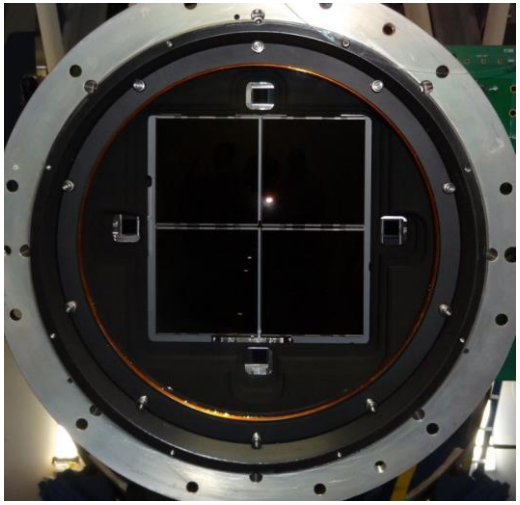
BOAO 1.8m telescope

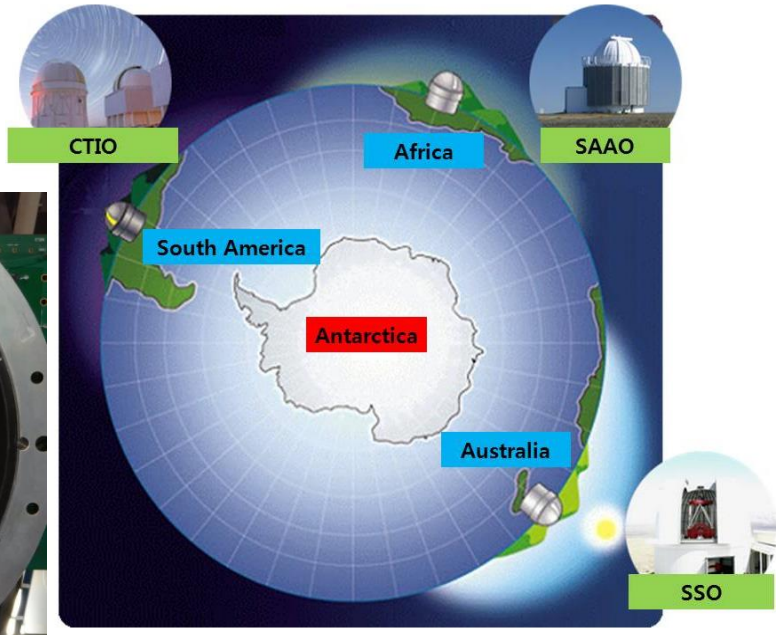
- **Bohyunsan Optical Astronomy Observatory**
- **built in 1996**
- **a 1.8m reflecting telescope**
- **Instruments**
  - 4k CCD camera
  - BOES (Bohyunsan Optical Echelle Spectrograph)
  - Near Infrared Camera System (KASINICS)
- **~60 observation programs in average**
- **6 international programs**
- **Main Research Fields**
  - Star Formation
  - Galaxy formation
  - Quasars



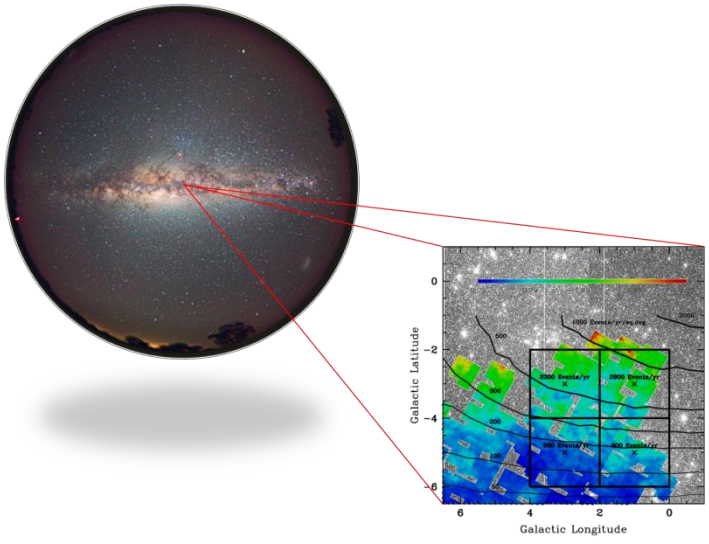
Korea Microlensing Telescope Network

- System overview
  - 1.6m telescope with FOV 2 deg x 2 deg and 340Mpixel CCD Camera
  - Three identical systems installed at CTIO in Chile, SAAO in South Africa, SSO in Australia.
  - 24-hours uninterrupted monitoring of night sky at Southern Hemisphere

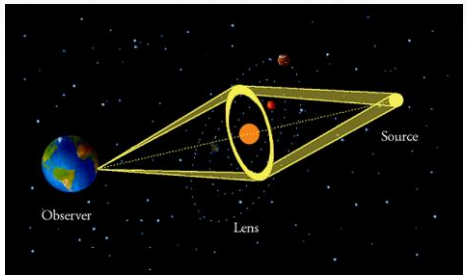


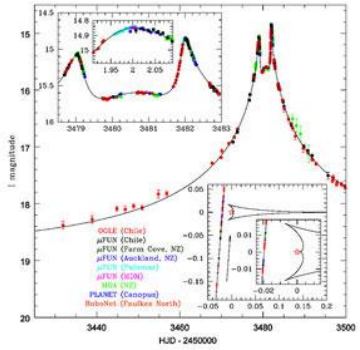


KMTNet Main Science



Monitoring the Galactic Bulge



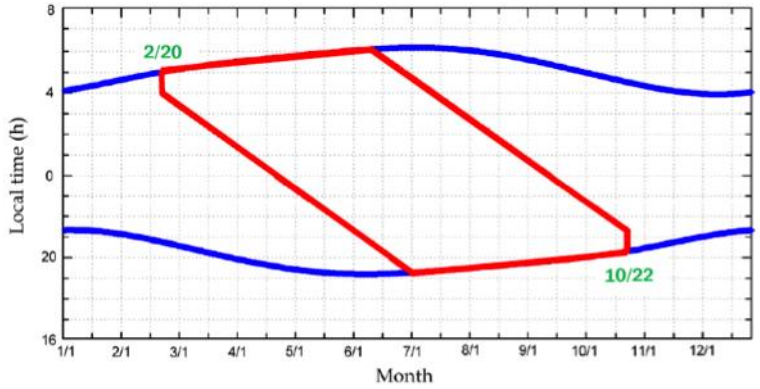


Detection of micro-Gravitational Lensing events

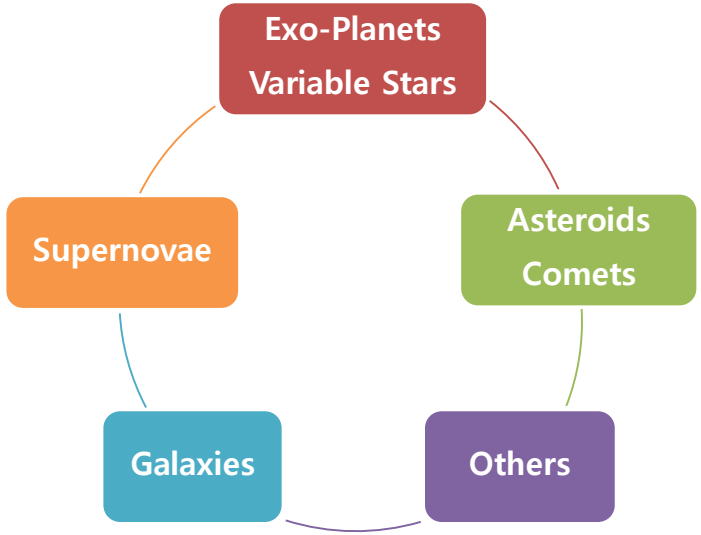
Discovery of **extra-solar planets**

KMTNet Science Cases

- **Galactic Bulge Season (Red)**
  - Search for Extra-solar Planets, especially, Earth-mass Planets in the Habitable Zone, using the micro-lensing technique
  - Survey of Transiting Planets & Variable Stars

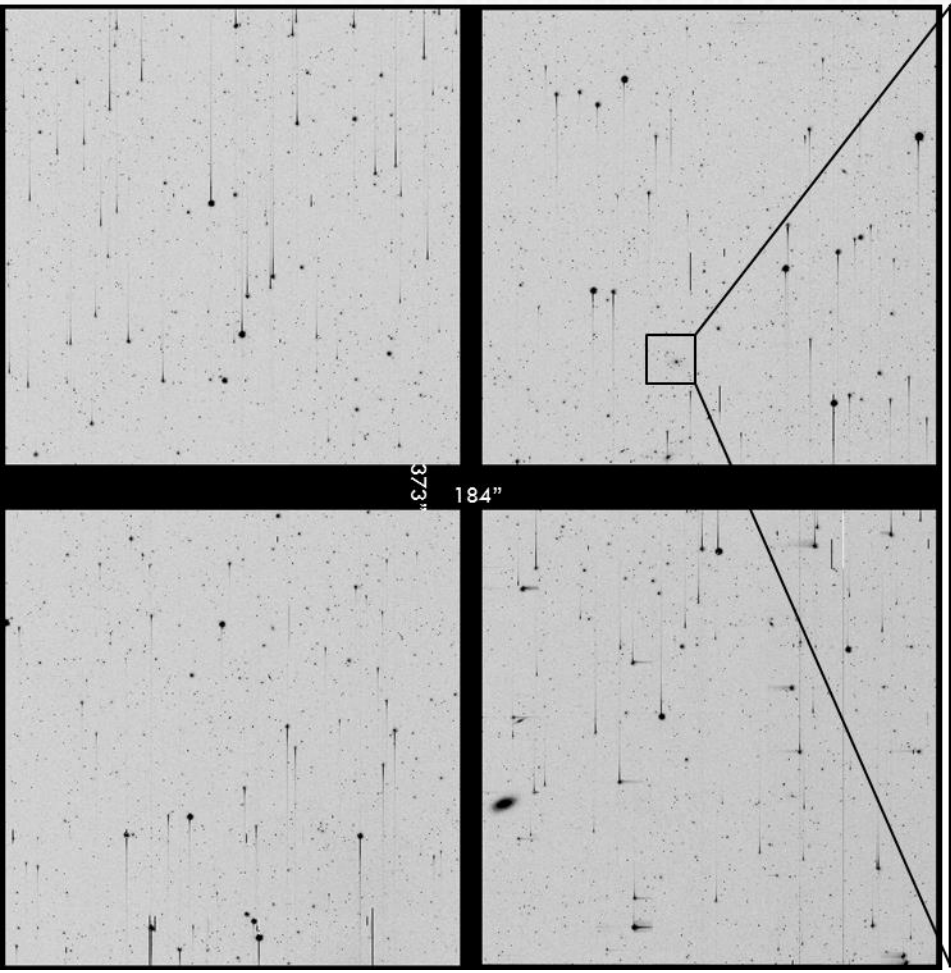


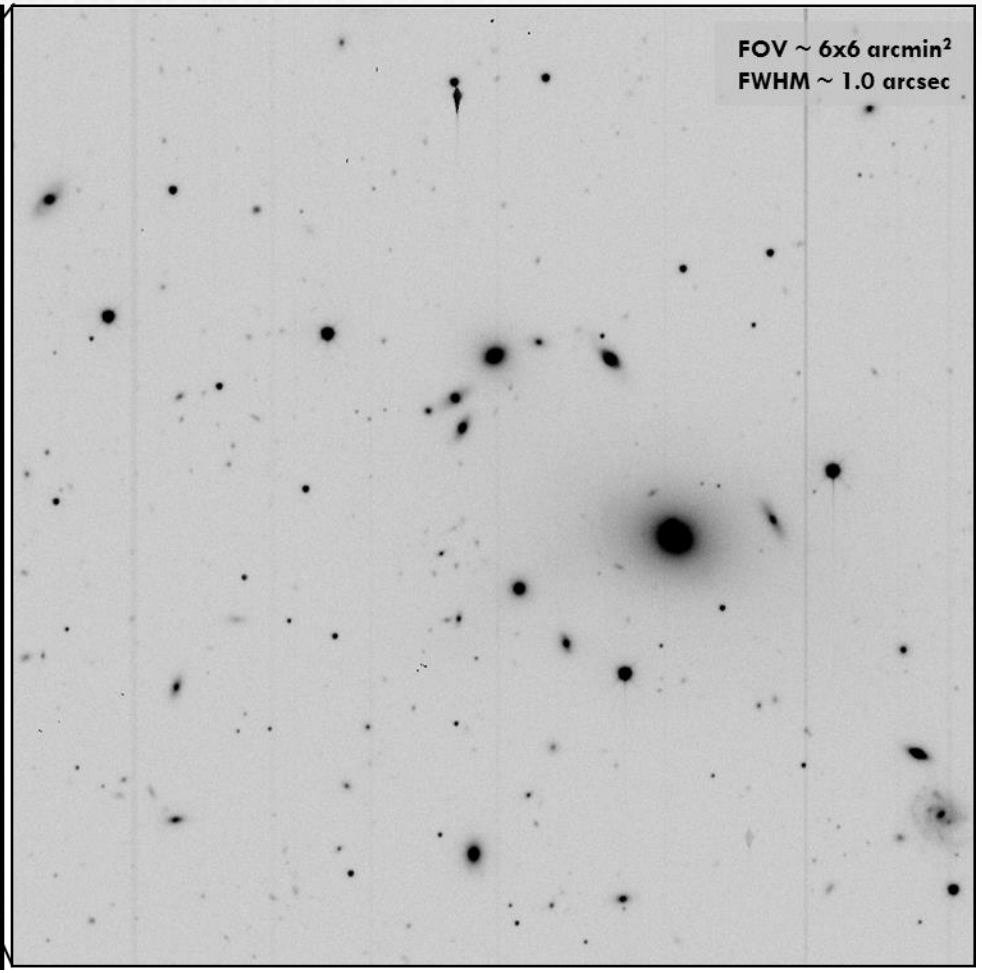
- **Non-Bulge Season (Blue)**
  - Survey of Supernovae
  - Survey of Asteroids and Comets especially, NEOs (Near-Earth Objects)
  - Multiband Photometry of External Galaxies
  - Others (e.g. Collaboration with Host Countries, Target of Opportunity)



KMTNet Early Results

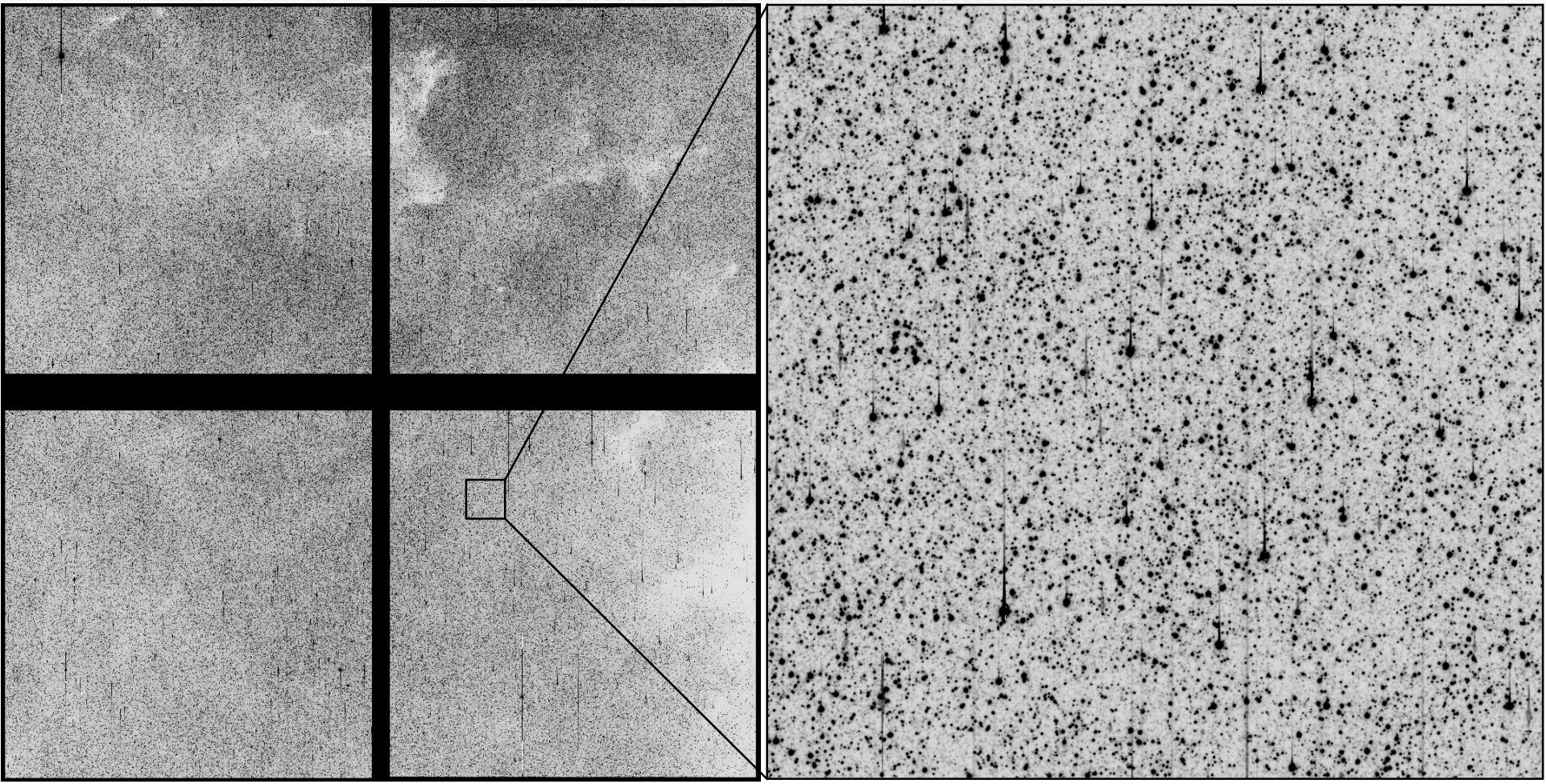
- Cluster of galaxies on 21 February, 2015 at CTIO. 120 seconds exposure with R filter





KMTNet Early Results

- Galactic Bulge on 21 March, 2015 at SAAO. 60 seconds exposure with I filter



KMTNet Early Results

- Complete light curve of OGLE-BLG-RRLYR-7412 (Kim et. al 2016, JKAS 49, 37)

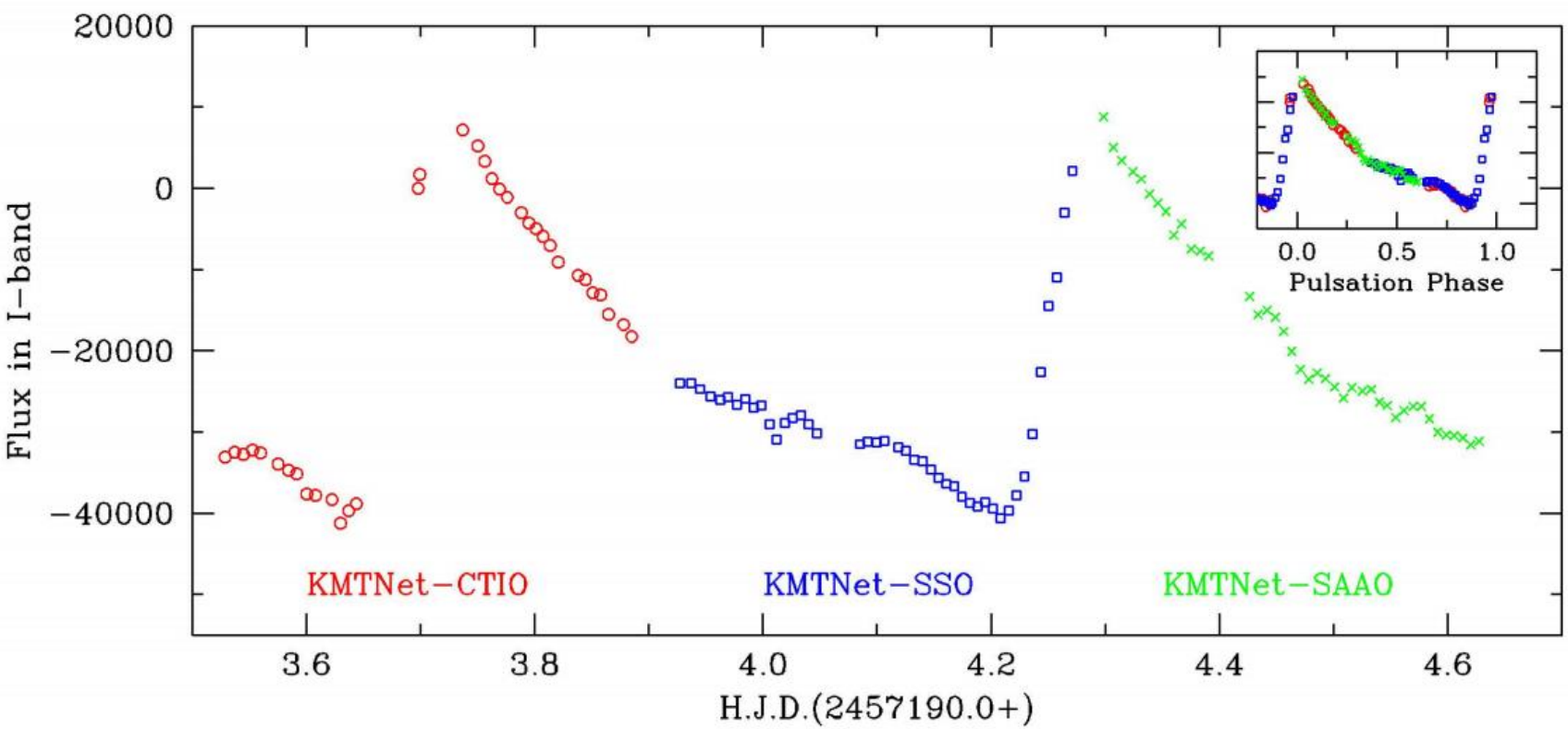
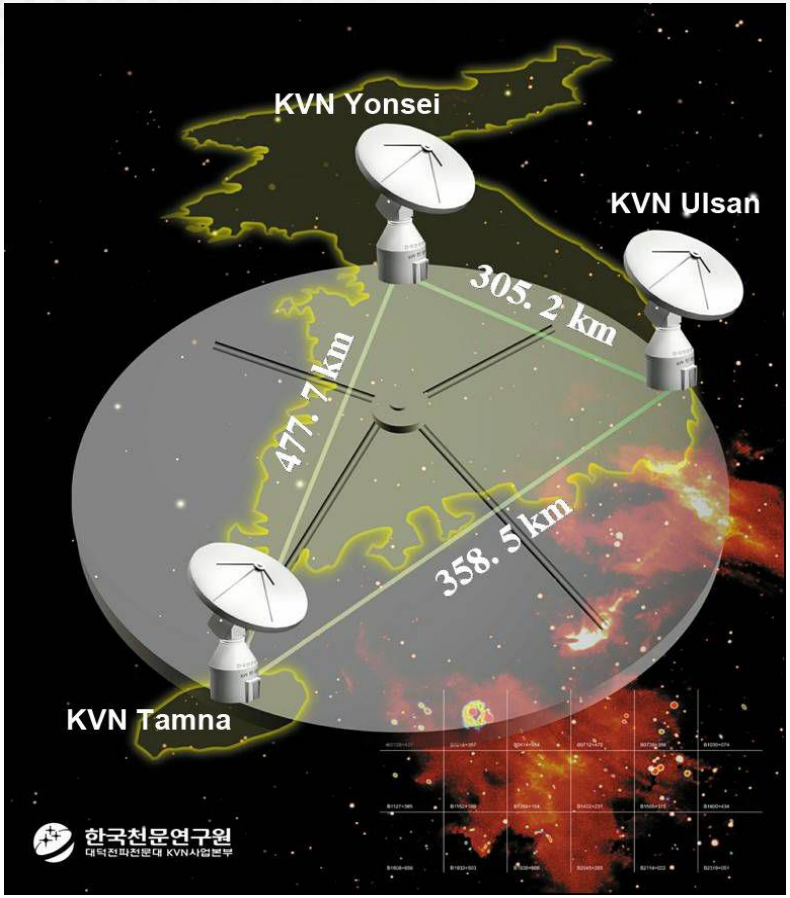


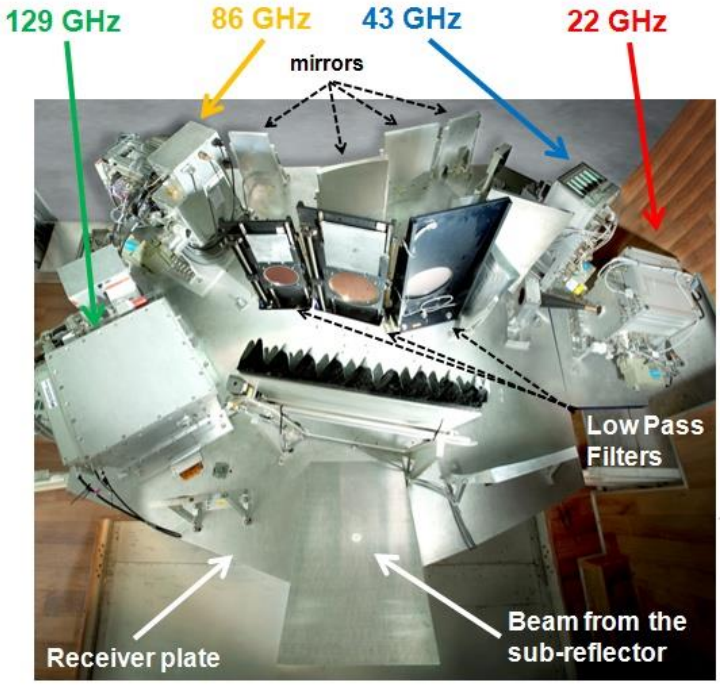
Figure 6. Sample light curves of the RR Lyr-type pulsating star OGLE-BLG-RRLYR-7412 in the Galactic bulge field, which was observed continuously at the three KMTNet sites on June 20, 2015. The flux is in arbitrary units. The upper right corner shows the star's pulsation phase diagram.

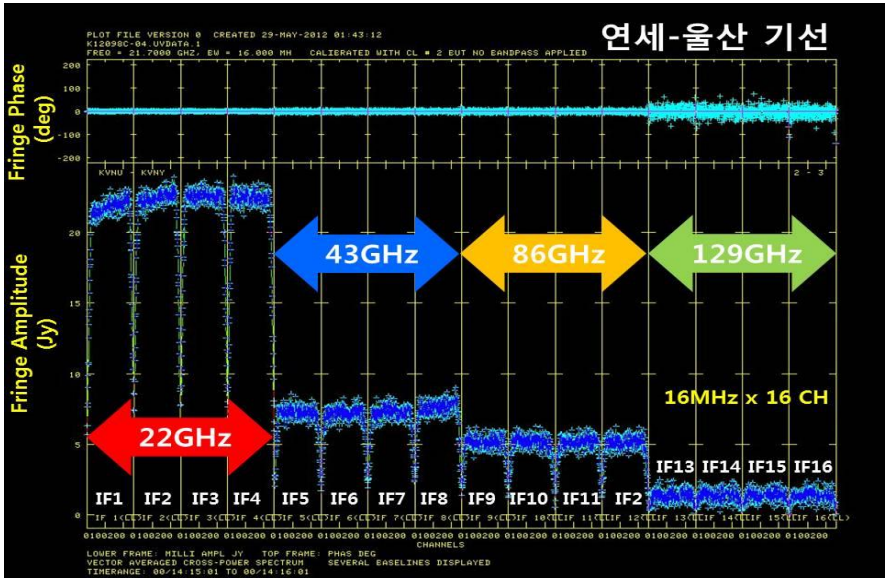
KVN

- **Korean VLBI Network**
  - Three 21-m radio telescope in Seoul, Ulsan, and Jeju (Tamna)
- **Completed in 2008**
- **simultaneous 4-band observations**
  - Detection of fringes simultaneously at 4 frequency-bands with 3 KVN-stations
- **Expansion: Successful VLBI observations with Japan, Europe, and Australia**
  - KVN + VERA
  - KVN + EVN



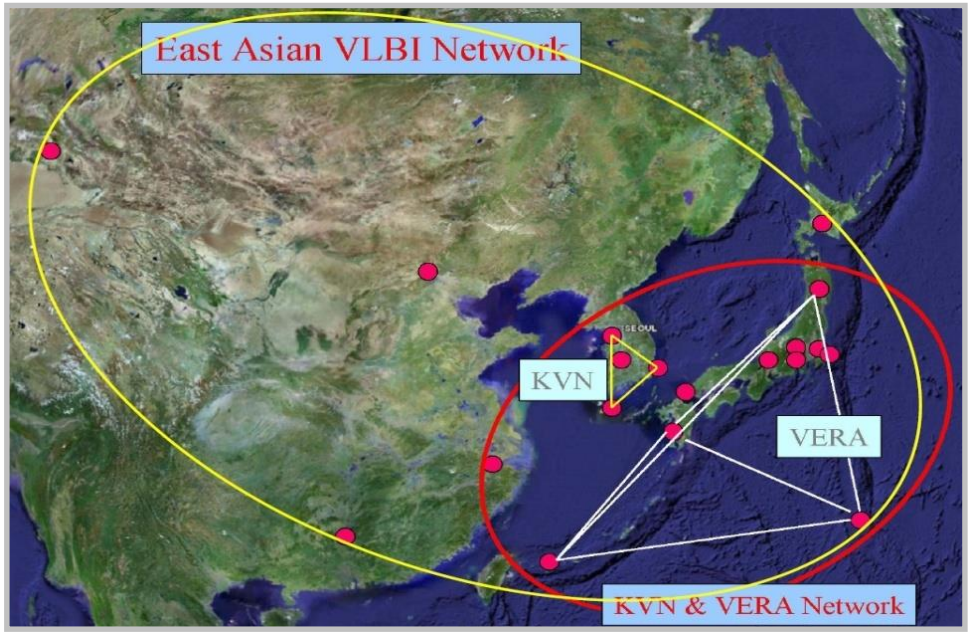
- **Multi-Frequency Receiving System**
  - simultaneous multi-frequency observation @ 22 /43 /86 /129 GHz to compensate atmospheric phase fluctuation using phase solution of low frequency





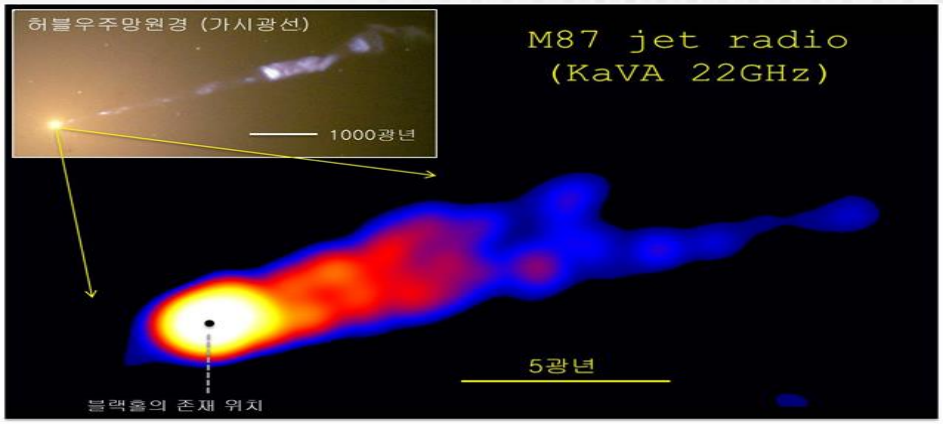
KVN

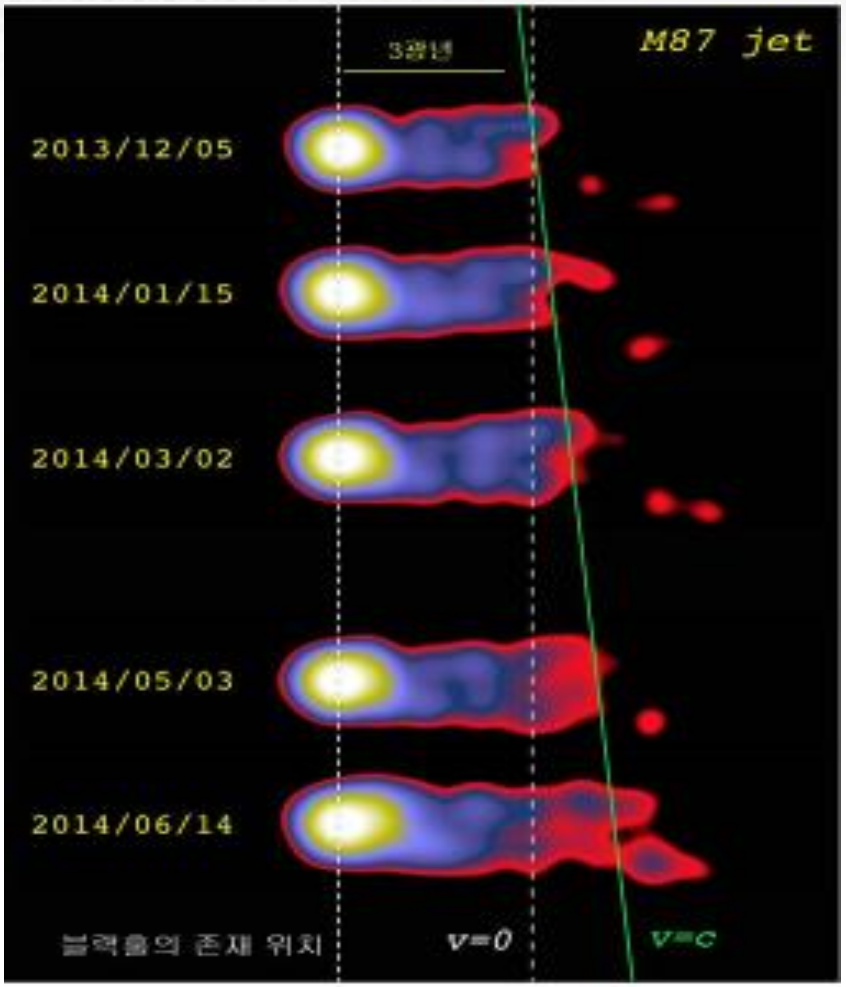
- **Korea-Japan Correlation Center (KJCC)**
  - Joint development and operation of VLBI Correlator System by KASI and NAOJ
  - VLBI data correlations of domestic (3 KVN-stations) and international VLBI observations (7 [KVN+VERA]-stations)
  - A Hub for international collaborations on the East Asian VLBI research activities



KVN Highlight

- **KVN + VERA (KaVA) : Jet from the core of M87 @ 22 GHz**





Jet velocity was measured as ~80% of c at the distance of 5ly from the central blackhole, previous measurement was 10% ~ 30%

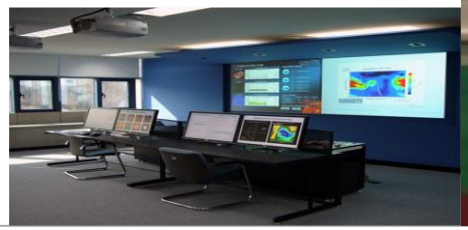
Space Weather Prediction Center

- **Forecasting of Space Disaster**
  due to the rapid change in space environment and solar activity

- In order to protect against
  - satellite lifetime shortening,
  - satellite body exposure,
  - satellite communication failure

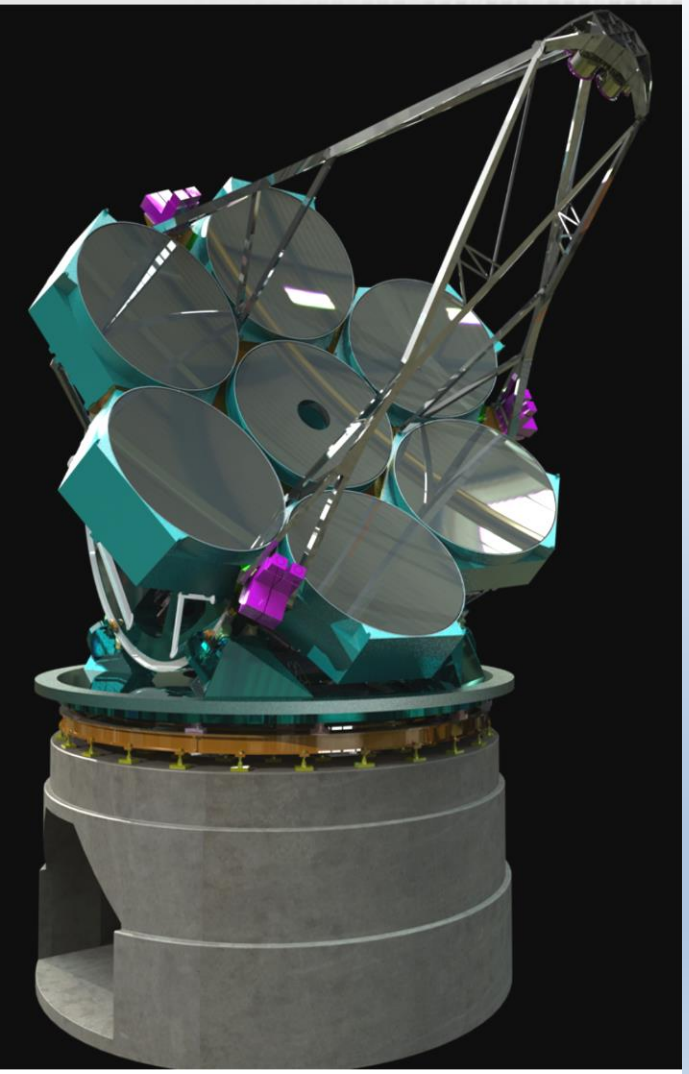
- **Solar Dynamics Observatory Data Center(2012)**
  - Space weather forecast with the highest resolution SDO solar image

- **Radiation Belt Storm Probe Data Center(2012)**
  RBSP Satellite Data receiving and distributing



III RESEARCH PROJECTS

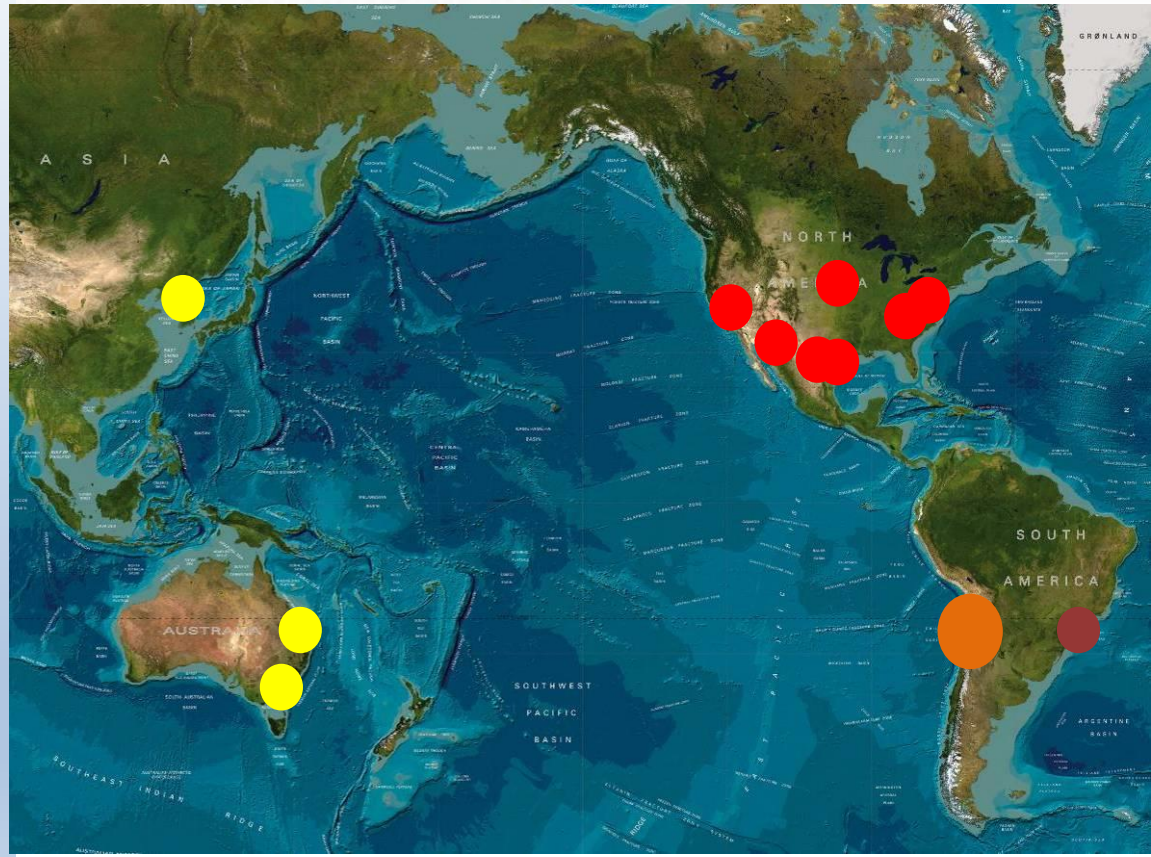
GMT



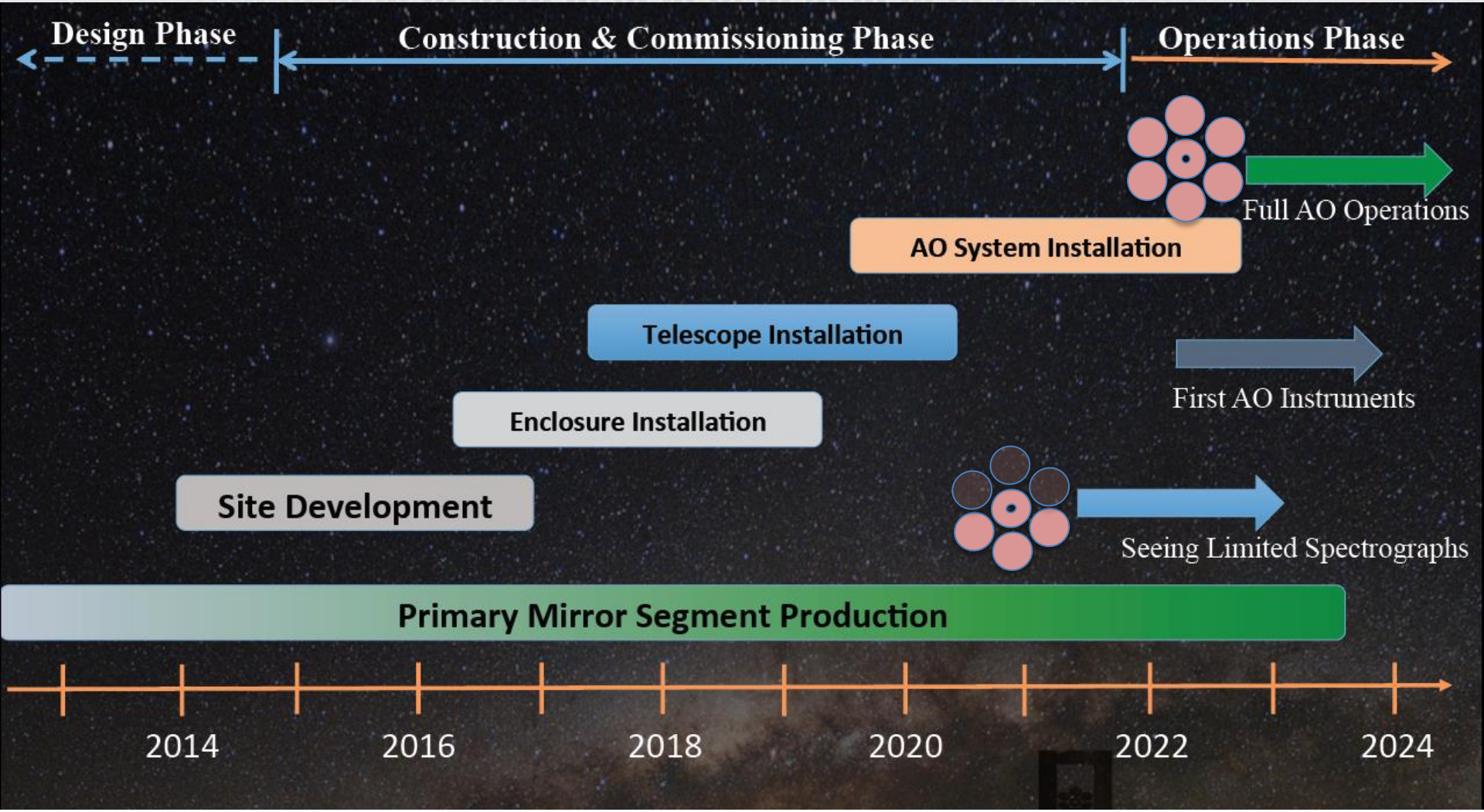
- Optical Characteristics
  - Seven 8.4m primary segments
    - Total diameter : 25.4m (area equiv. to 22m)
  - Seven 1.06m secondary segments
    - Total diameter : 3.2m
    - Fast Steering Mirrors & Adaptive Secondary Mirrors
  - Gregorian Focus
    - f/8, FOV ~ 20 arcmin
- Alt-Azimuth Mount
- Dimension
  - Height : 38.7m
  - Weight : 1,123 ton
- Site : Las Campanas Peak, Chile

GMT Partners

- U.S.A. – 7 institutions
  - Carnegie Observatories
  - Harvard University
  - Smithsonian Institute
  - University of Arizona
  - University of Texas
  - Texas A&M University
  - Chicago University
- Australia
  - Australian National University
  - Astronomy Australia Limited
- Korea
  - KASI
- Brazil
  - FAPESP (San Paulo Research Foundation)



GMT Masterplan



GMT Construction begins

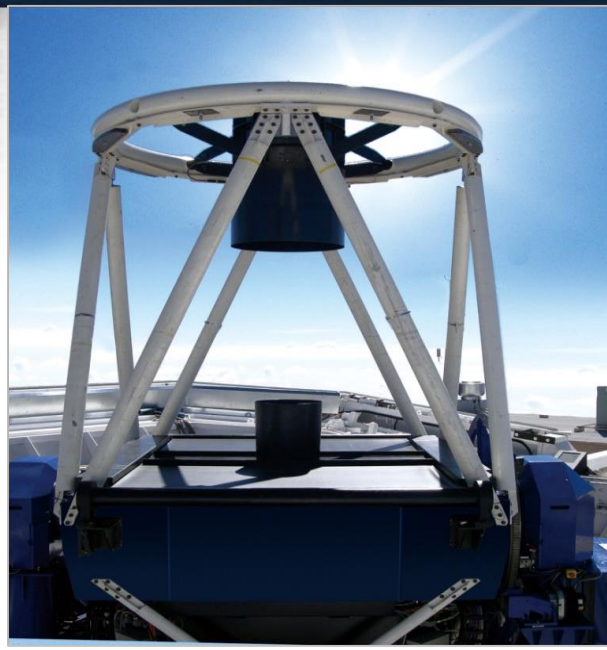
Korean GMT Participation

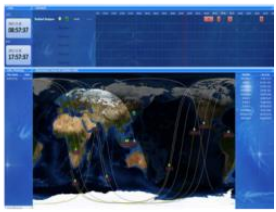
- **Acquire 10% share of the GMT**
- **Promotion of Korean Research Capability**
  - Access to 4m ~ 8m class telescope for Korean community
  - International collaboration with GMT partner institutions
  - Participation in survey projects
  - Annual summer school for students

- **Promotion of Korean Technical Capability**
  - Development of GMT secondary mirrors (FSM)
  - Participation in the development of GMT 1st generation instruments (G-CLEF, GMTNIRS)
- **Encourage of Industrial Participation in GMT Construction**
  - Participation in the bidding for
    ; enclosure
    ; telescope mechanical mount
    ; Precision drives, HSB, etc.

OWL

- **O**ptical **W**ide-field patro**L (OWL) (2016)**
- Electro-optic Space Surveillance System
  - Multiple stations with 0.5m optical telescope located worldwide
- Protecting national space asset against hazardous space objects
  - Optical tracking of Korean LEO satellites
  - Optical surveillance of the GEO belt covering Korean peninsula
  - Optical surveillance of space debris hazardous to Korean satellites





SLR

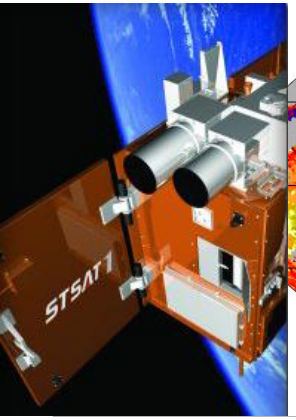
- **S**atellite **L**aser **R**anging System
- **Development of Mobile SLR system (40cm, 2012)**
- **Development of Fixed SLR system (1m, 2015)**
- **Development of SLR data processing technology**
  - High-precision orbit determination(mm accuracy)
  - Space geodesy research using SLR data
  - Supporting the national space surveillance system

IV

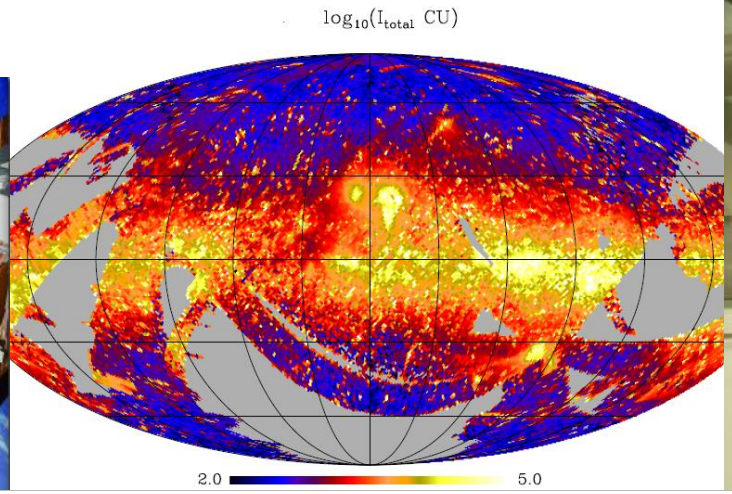
IR AND SPACE TECHNOLOGIES

Space Observation Programs

- **Science & Technology Satellite Series (KARI)**
  - 1st Satellite: FIMS (**F**ar-ultraviolet **IM**aging **S**pectrograph, KASI) (2003)
  - 2nd Satellite: Observation of Space environment by Korean Launcher Naro
  - 3rd Satellite: MIRIS (Multipurpose Infrared Imaging System, KASI) (2013)



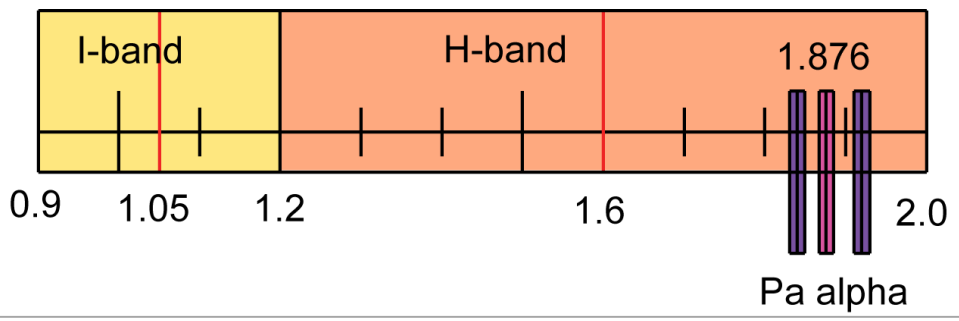
(Seon et al. 2011)

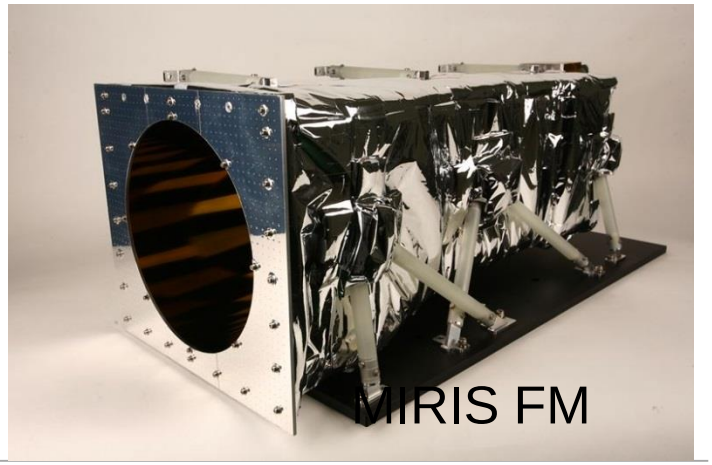


ST-SAT II

MIRIS

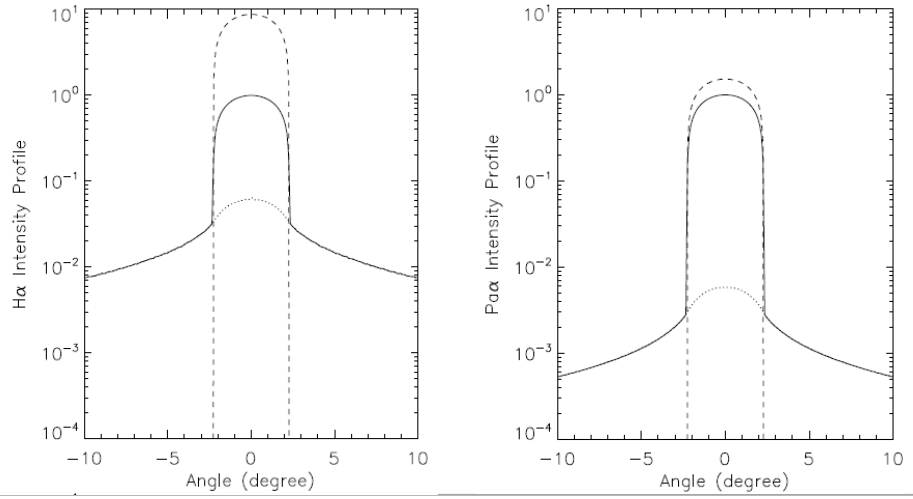
- **M**ulti-purpose **I**nfra**R**ed **I**maging **S**ystem
- Specifications of Space Observation Camera
  - Wavelength : 0.9 ~ 2μm
  - Aperture: 80 mm
  - Pixel FOV : 51.6 arcsec (c.f. Nyq. sampling @ 1.6μm = 4.1 arcsec)
  - Detector FOV : 3.67° x 3.67°
  - 5 Filters: I (1.05μm), H (1.6μm), blank, Pa α (1.876μm), Pa α Cont
- Collaboration with ISAS/JAXA → Technical consultation & Science
- Launch: November in 2013

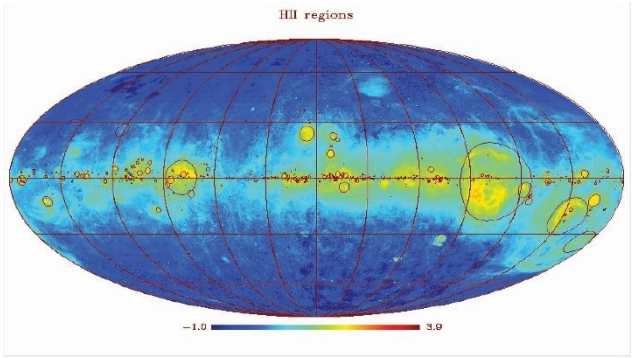




MIRIS Scientific Objectives

- **Paα Emission Line Survey : Galactic plane & WIM**
- **Origin of Warm Ionized Medium**
  - Previous study of WIM: Photoionization model
  - Recent study of WIM from FIMS: dust scattering
  - Verification of the dust scattering theory
- **Physical properties of interstellar turbulence**
  - Structure of WIM
  - Comparison between Paα (MIRIS) vs. Hα

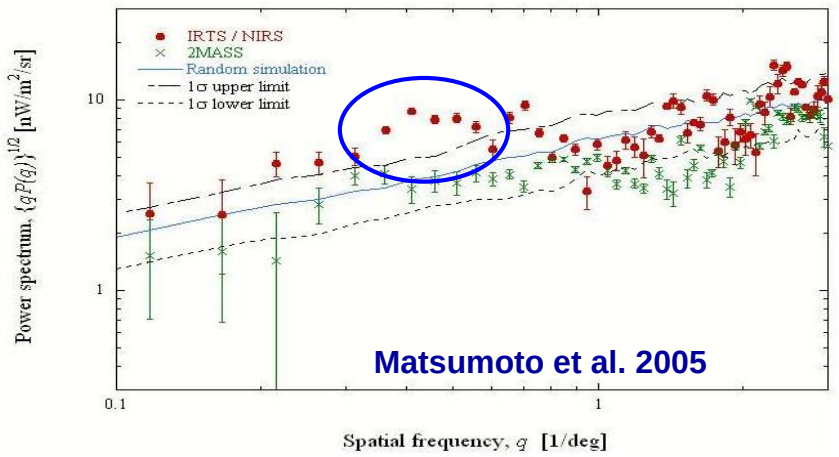




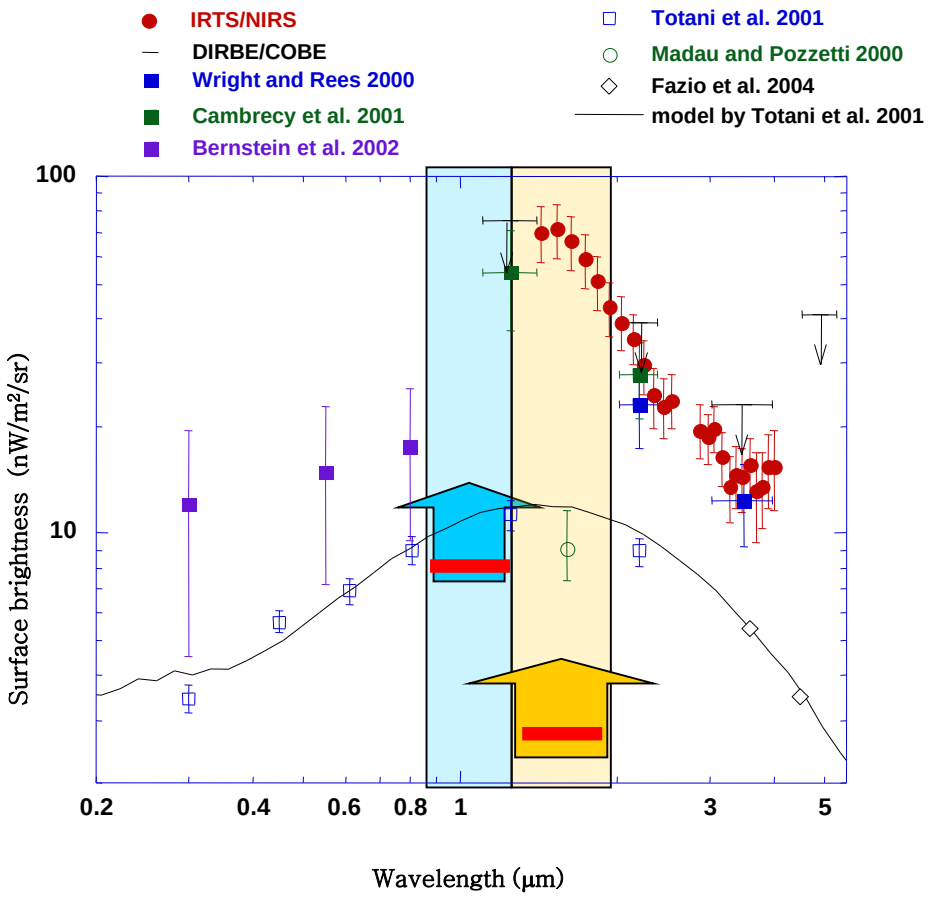
- Monte-Carlo simulation
  - Uniform dust distribution; E(B-V) = 0.1
  - Point source or Spherical H II region

MIRIS Scientific Objectives

- **Observation of Cosmic Infrared Background (CIB)**
  - CIB from POPIII stars
  - Spectral peak of CIB
  - Large scale fluctuation of CIB

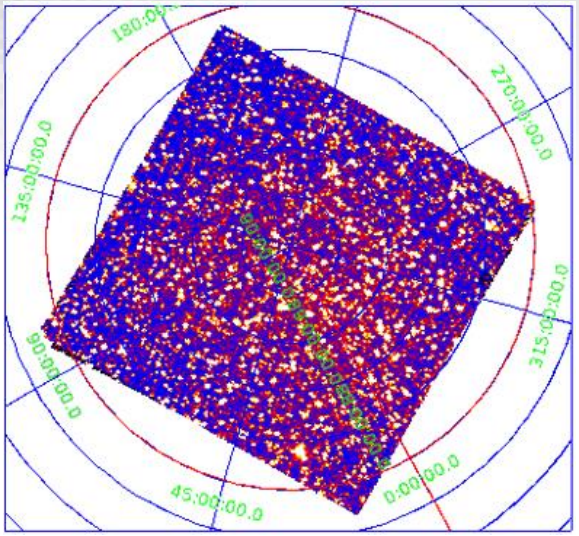


Large-scale structure of CIB from IRTS observation

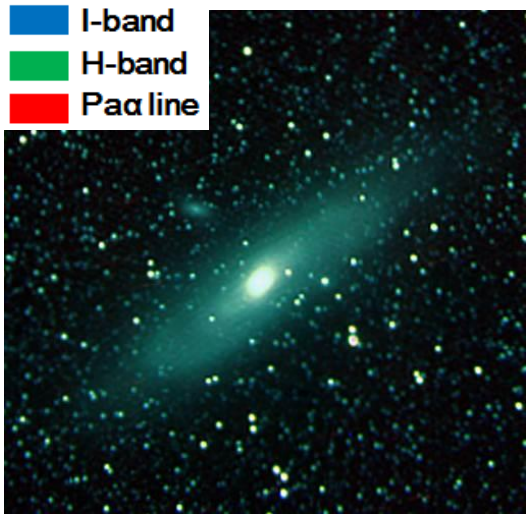


MIRIS in Operation

- Phase I observation : CIB observation
- In Phase II : Paα survey of GP (2014)

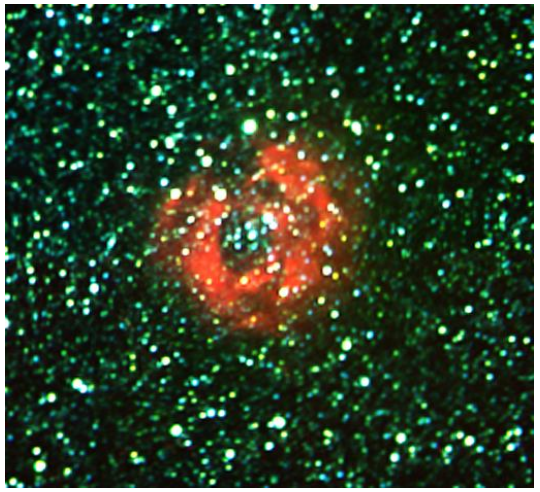


NEP field



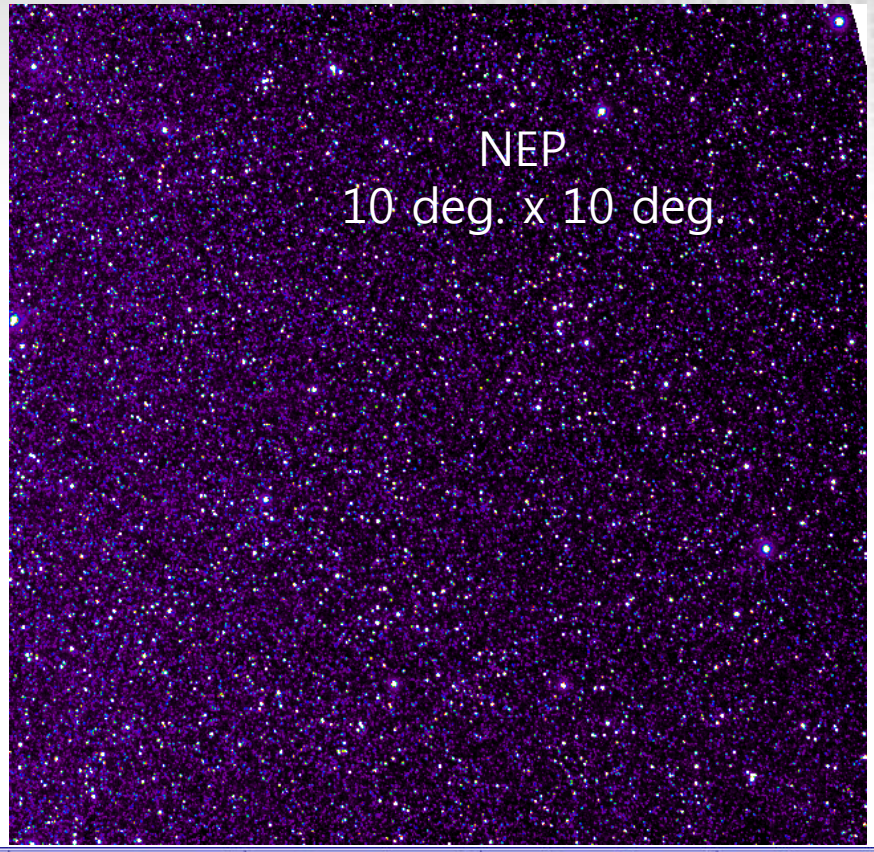
M31

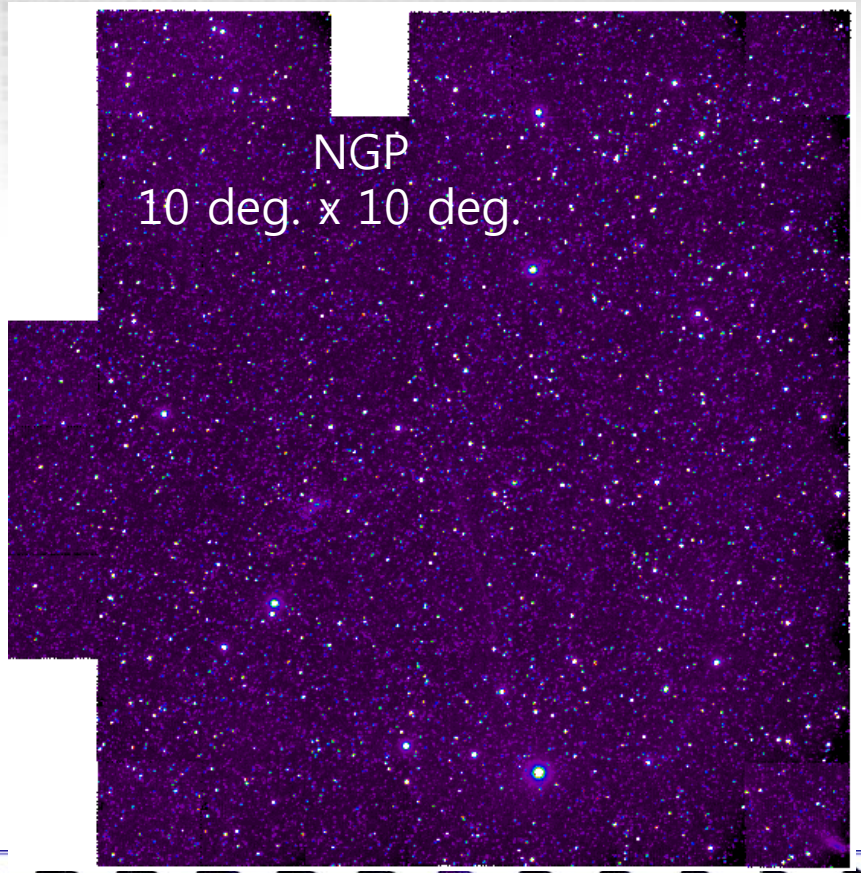
Orion Nebula



Rosette Nebula

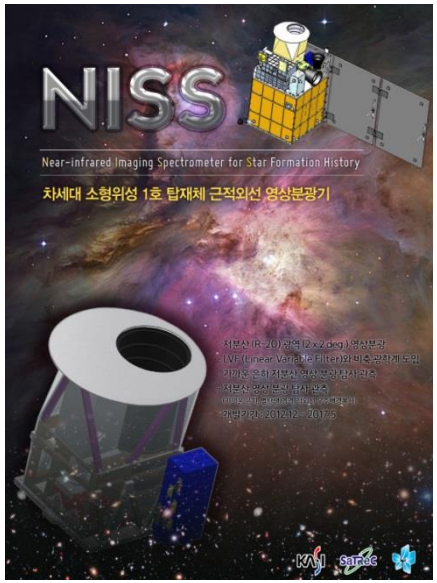
MIRIS Images (preliminary)





NISS Project

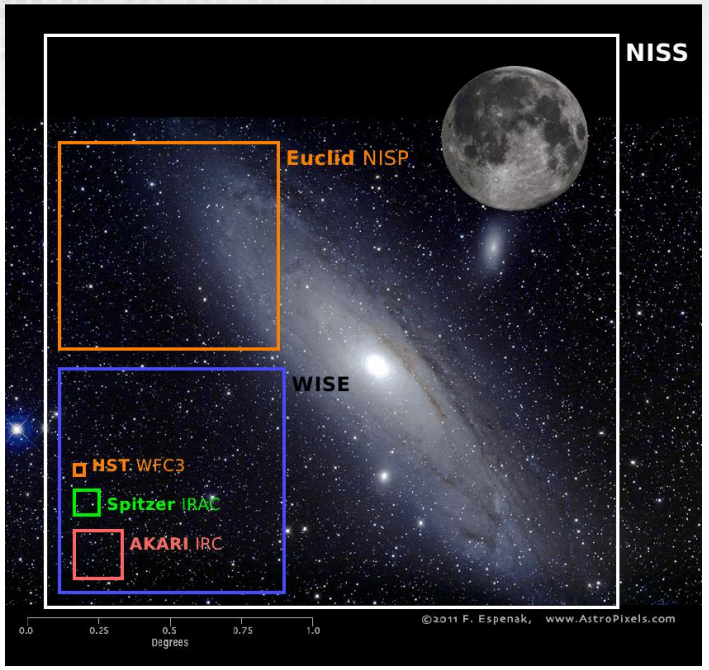
- **Basic Design Concept of Project**
  - Near-IR Instrument onboard small satellite (NEXTSat-1)
    - Small mechanical cooler/ radiative cooling: near-IR range
    - Recent observations in the near-infrared
      → Wide-area survey & low-resolution spectroscopy in space
  - Cosmic Star formation history
    - Efficient observation in space
    - Near-IR observation: local / distant Universe
    - Wide FoV
      → Near-Infrared Imaging Spectroscopy

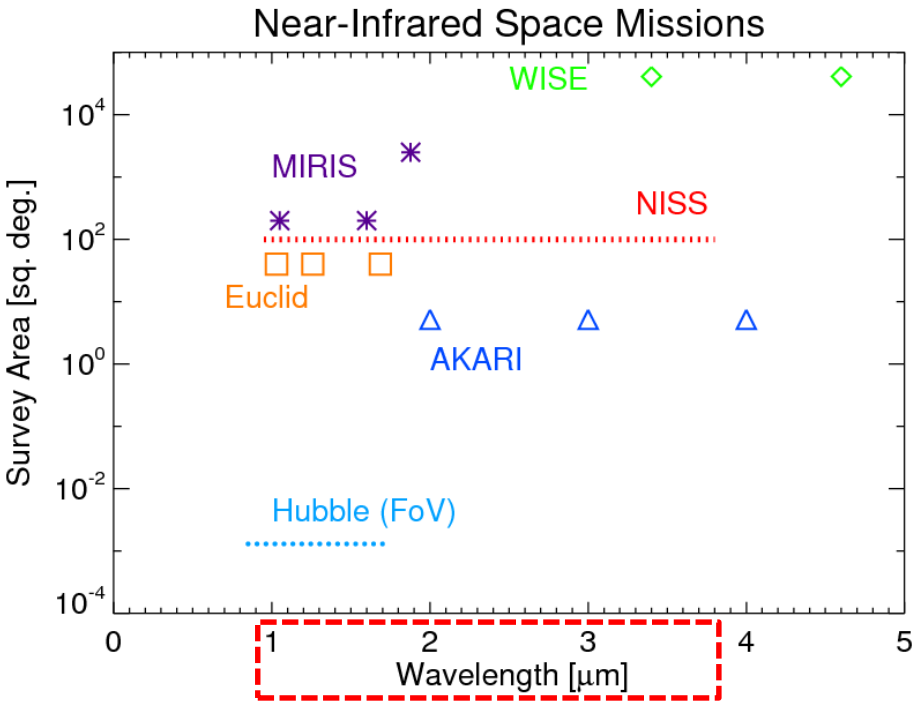


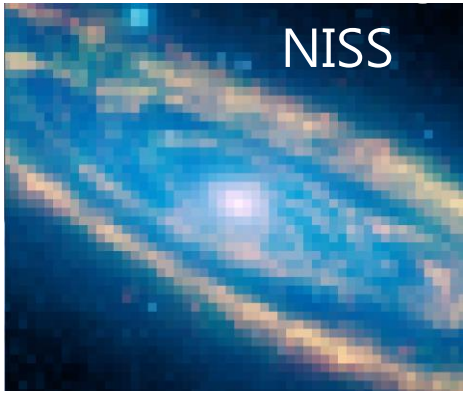
- Development Period : 2012.12 ~ 2017.05 (4.5 yrs)
- Launch : 2017. 07

NISS Project

- **Wide FoV & Improved Resolution**
  - (~ 4 sq. deg. , 15 arcsec pixel, 150 mm)
- **Near-Infrared Imaging Spectroscopy**







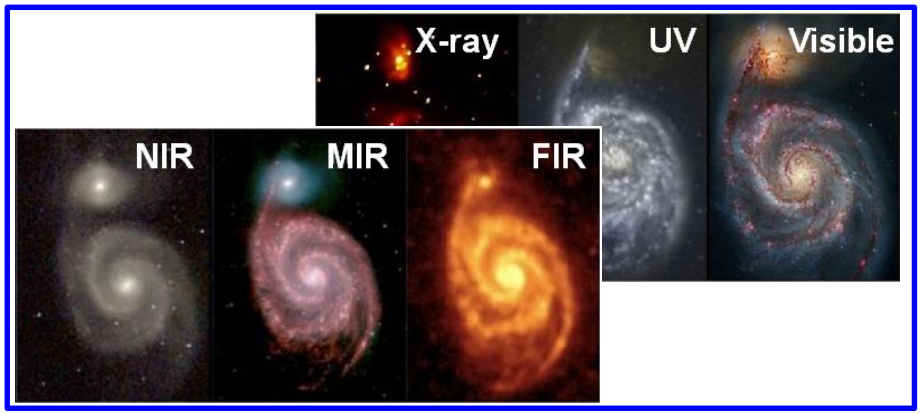
NISS Science Mission

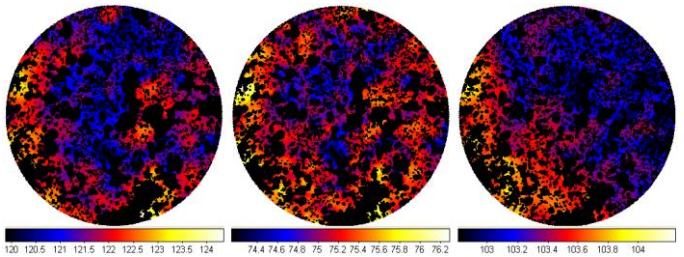
- **Near-IR Imaging Spectroscopy**
  - Large Nearby galaxies / Clusters of galaxies
  - Star-forming regions
  - Cosmic Near-Infrared Background

Near-Infrared Emission Lines

λ (μm)	line	Type
1.26, 1.64	[Fe II]	Emission
1.875	**Paα**	**Emission**
1.96	[Si IV]	Emission
2.212	H_2 1-0 S(1)	Emission
3.05	**H_2O Ice**	**Absorption**
3.3	**PAH**	**Emission**

Multi-wavelength observation for M55
NISS: Complementary information in NIR





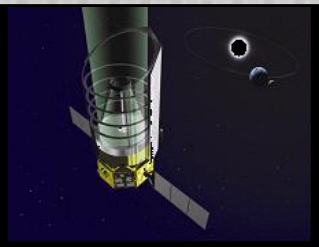
Detection of Cosmic Near-Infrared Background (2~4μm)

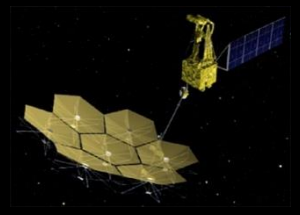
Roadmap for Space Science in Korea

L2
(1.5x10^5 km)

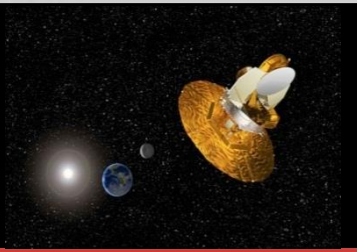
Moon
(3.8x10^4 km)

LEO
(7x10^2 km)





[2nd Stage: International Collaboration in Large Space Project]

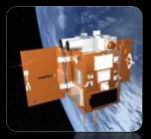


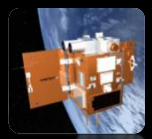
[Challenging Mission] Korea-leading Large Space Mission

Synergy with GMT

[3rd Stage: Korean Space Telescope]

NISS





[1st Stage: NEXTSat Series]
- Demonstration of Space Technologies
- Preceding Study of Space Sciences

Space Vision 2030

2010 2015 2020 2025 2030 2035 2040

V

COLLABORATIONS AND OPPORTUNITIES

Regional and Global Collaborations

- **EACOA and EAO (http://www.eacoa.net)**
  - EACOA (East Asian Core Observatories Association) since 2005 by KASI, NAOJ, NAOC and ASIAA
    → EACOA Fellowship Program, East Asian Meeting for Astronomers

  - EAO (East Asian Observatory) since 2015 by EACOA member institutes
    → First EAO telescope : JCMT

- **COSPAR (For Korea: http://cospar.kasi.re.kr/eng/index.php)**
  - COSPAR (Committee on SPAce Research) since 2012
  - 3rd COSPAR Scientific Symposium in 2017 will be held in Korea

- **SCOSTEP (Scientific Committee on Solar-Terrestrial Physics), ILWS (International Living With a Star), etc.**

Research Opportunities in KASI

- University of Science and Technology
- KASI Post Doc. Fellowship
- KASI Fellowship
- KASI Distinguished Scholar
- National Research Foundation Brain Pool Program

Conclusions

- We are making **steady progress** in research and instrument developments.
- We expect fast growth in both quantity and quality of research output, moving from fast follower to ***First Mover.***
- We are strengthening **international collaboration**.

Thank you !

Korea Astronomy and Space Science Institute