PPS04-01 Room:A03 Time:May 27 12:00-12:25

How we built ALMA

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The Atacama Large Millimeter/submillimeter Array (ALMA), an international partnership of the European Organisation for Astronomical Research in the Southern Hemisphere (ESO), the U.S. National Science Foundation (NSF) and the National Institutes of Natural Sciences (NINS) of Japan in cooperation with the Republic of Chile, is the largest astronomical project in existence. ALMA is a single telescope of revolutionary design, composed initially of 66 high precision antennas located on the Chajnantor plateau, 5000 meters altitude in northern Chile. The National Astronomical Observatory of Japan (NAOJ), a branch of NINS, is taking the role of the Executive for the 25% contribution from East Asia to the project. ALMA is now in its full operation and producing exciting scientific data, such as the astonishing image of the grooved protoplanetary disk surrounding HL Tau.

In this paper, I will introduce the lights and shadows of this worldwide collaboration that built ALMA, based on my 7-year experience in Chile working for the project.

Keywords: radio astronomy, ground-based, international collaboration, large project

PPS04-02 Room:A03 Time:May 27 12:25-12:45

International collaboration in space solar physics

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Before coming to ISAS on April, 2013, I had worked for the National Astronomical Observatory of Japan as an astronomer, and had been involved in 4 satellites, 2 balloons, and 2 sounding rocket experiments. I have been observing the sun with these missions in the past 30 years.

I started my career with hard X-ray and gamma ray instrumentation in 1970s in ISAS Hinotori solar satellite as a graduate student, then moving to the development of the soft X-ray telescope with NASA in 1980s for ISAS Yohkoh mission, proceeding to the visible light space telescope again developed with NASA from late 1990s for ISAS Hinode satellite. I had proposed the basic concepts of both the Yohkoh and the Hinode missions with my colleagues. Solar physics has been enjoying the golden age in the past 25 years with Yohkoh and Hinode. In particular, very successful Yohkoh changed the dim scenery of the discipline, and paved the way for series of space solar missions thereafter.

Yohkoh and GEOTAIL would be the first two missions for which NASA decided to work with Japan in a significant way. That happened as early as 1986. Missions such as Hinode, Suzaku, ASCA, GEOTAIL and Yohkoh were tremendous success affecting not only that disciplines but to all space science. International collaboration as a means to combine assets scattered in the world namely good people, technology and money has to be pursued ever more in this turbulent era for the sake of science. ISAS/JAXA is always seeing for collaboration with international partners for any ISAS/JAXA missions. We are also eager to participate in missions led by foreign agencies.

Keywords: Space Science

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PPS04-03 Room:A03 Time:May 27 14:15-14:30

International collaboration driven by the STPP sub-committee under the Science Council of Japan

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To date, the Solar Terrestrial Physics Program (STPP) sub-committee has been promoting and supporting several international programs. For example, it supported International Heliophysical Year (IHY), a major initiative launched by the United Nations from 2007 to 2009. In broad terms, IHY dealt with the solar system, paying a particular attention to the effects of the Sun on the Earth's upper atmosphere and on the space environment in the vicinity of the Earth. The United Nations Office for Outer Space Affairs (UNOOSA) coordinated observation campaigns and drew scientists and engineers from all over the world to enhance its Basic Space Science Initiative (BSSI). Several international workshops were organized by UNOOSA to advance the benefits of IHY to all corners of the world. To maintain the international momentum created by IHY, UNOOSA developed the International Space Weather Initiative (ISWI) to achieve more basic understanding of the solar terrestrial relationship. ISWI ran from 2010 to 2014, and there was an international workshop for each year of ISWI (i.e., at Cairo, Abuja, Quito, and Graz).

From another vantage point, UNOOSA established in 2010 a new working group (WG): Long Term Sustainability of Outer Space Activity (LTSOSA). This working group was created to cover a wide area: From the natural space environment (Space Weather) to the artificial space environment (Space Delis). The LTSOSA WG set up four expert groups in 2011. Expert Group for Space Weather is one of the expert groups and the author (T. Obara) was assigned to be one of the co-chairs of the space weather expert group.

The space weather expert group members gathered several times, and compiled a 50-page working group report (A/AC.105/C.1/2014/CRP UN COPUOS REPORT, 2014). This report contains:

Identification of risks from space weather,

Observations, models, tools for space weather prediction,

Comprehensive network space weather services,

Coordination on data and services to safeguard space activities,

Engineering approaches to mitigate space environment effects,

Recommended guidelines for the long-term sustainability of space activities.

The Solar Terrestrial Physics Program (STPP) sub-committee of the Science Council of Japan has been in charge of these UN-mandated programs for the interface with Japan. The STPP is considering to propose follow-on UN programs, and the STTP is also considering to take on responsibility for other programs such as multinational and international space weather programs, such as AOSWA (Asia Oceania Space Weather Alliance).

In this presentation, details shall be presented to give a better idea about the goals and functions of STPP.

Keywords: STPP sub-committee, the Science Council of Japan, International Collaboration, Past and Future

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PPS04-04 Room:A03 Time:May 27 14:30-14:45

Variability of the Sun and Its Terrestrial Impact (VarSITI): SCOSTEP's scientific program in 2014-2018

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During the last solar minimum, solar activity was extremely low for an extended period, and the present maximum of sunspot cycle 24 is the lowest in the last 100 years. It is not clear what long-term solar activity variations we can expect in the future: whether this is just the end of the recent decades of high solar activity, or whether the Sun is entering a Maunder-type minimum. Moreover, it is not clear to what extend our present understanding of how the Sun influences the geospace - which is based on instrumental observations taken during only the period of high solar activity in the second part of the 20th century - will hold during periods of more moderate to low solar activity that may follow. And it is still more unclear how all this would affect global climate change, or how important becomes the penetration of various inputs from the Earth's lower atmosphere to the ionosphere and plasmasphere. In 2014-2018 the Scientific Committee On Solar-TErrestrial Physics (SCOSTEP) operates the scientific program "Variability of the Sun and Its Terrestrial Impact" (VarSITI) which will focus on the recent and expected future solar activity and its consequences for the Earth, for various time scales from the order of thousands years to milliseconds, and for various locations and their connections from the solar interior to the Earth's atmosphere. In order to elucidate these various Sun-Earth connections, we encourage much closer communications between solar scientists (solar interior, atmosphere, and heliosphere) and geospace scientists (magnetosphere, ionosphere, and atmosphere). Campaign observations/data analysis for particular intervals, VarSITI web pages (http://www.varsiti.org/), mailing lists, and newsletters, are developed for this purpose. Four scientific projects are carried out under the VarSITI program: (1) Solar Evolution and Extrema (SEE), (2) International Study of Earth-Affecting Solar Transients (ISEST/MiniMax24), (3) Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN), and (4) Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate (ROSMIC). These four projects will be carried out in collaboration with relevant satellite and ground-based missions as well as modeling efforts to facilitate the implementation of the projects. We will also discuss the collaboration with other on-going international projects like the UN-based space weather activities, particularly for promoting VarSITI-related science in developing countries, and ICSU World Data System (ICSU-WDS).

Keywords: VarSITI, solar activity, climate change, heliosphere, magnetosphere, atmosphere

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PPS04-05 Room:A03 Time:May 27 14:45-15:00

The International Space Weather Initiative (ISWI)

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The International Space Weather Initiative (ISWI) is a scientific program of global cooperation to understand the external drivers of space weather. The science and applications of space weather has been brought to prominence because of the rapid development of space based technology that is useful for all human beings. The ISWI program has its roots in the successful International Heliophysical Year (IHY) program that ran during 2007 - 2009. The primary objective of the ISWI program is to advance the space weather science by a combination of instrument deployment, analysis and interpretation of space weather data from the deployed instruments in conjunction with space data, and communicate the results to the public and students. Like the IHY, the ISWI will be a grass roots organization with key participation from national coordinators in cooperation with an international steering committee. There have been more than 1000 deployments from 17 instrument concepts forming several instrument networks. This talk outlines the ISWI program including its organization and summarizes a few scientific results.

PPS04-06 Room:A03 Time:May 27 15:00-15:20

International collaboration in ground-based magnetometer observations via ULTIMA: A tribute to Professor Kiyohumi Yumoto

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Ground-based magnetometers provide not only the measurements of the geomagnetic field but also integrative information about of the electric currents in the magnetosphere and the ionosphere, revealing the dynamics of the magnetic storms, substorms, and various types of MHD and plasma waves in the geospace. Ground-based magnetometers are installed and operated by university teams and government agencies, most of which manage regional arrays for specific scientific objectives or national interests. Nonetheless, a global network of ground-based magnetometers is required to understand the complex geospace and its response to solar activity.

As the Principal Investigator of the world's largest magnetometer array operated by a single group, Professor Kiyohumi Yumoto envisioned that international collaboration was the only way to global magnetometer observations. In 2006, he and six other magnetometer arrays in Australia, Canada, and the United States founded the Ultra Large Terrestrial International Magnetometer Array (ULTIMA) consortium, of which he was elected as the first Chair. The main objective of ULTIMA is to promote collaborative research on the magnetosphere, ionosphere, and upper atmosphere through the use of ground-based magnetic observatories. The number of ULTIMA members doubled in size during Professor Yumoto's tenure between 2006 and 2014. Today, ULTIMA consists of 17 member arrays with over 250 stations located in all continents of the world. ULTIMA also received recognition from the International Association of Geomagnetism and Aeronomy (IAGA) in 2013.

We present a review of the establishment and development of ULTIMA, as well as lessons learned regarding collaboration among magnetometer teams in multiple nations. As geospace research has moved into a new era where collaborative opportunities among different types of observations are growing, we also demonstrate ongoing and upcoming synergetic activities participated by ULTIMA.

Keywords: ground-based magnetometers, ULTIMA, international collaboration, magnetic field, geospace

PPS04-07 Room:A03 Time:May 27 15:20-15:40

BepiColombo Euro-Japan Joint mission to Mercury

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[1]ISAS/JAXA

BepiColombo is a ESA-JAXA joint mission to Mercury with the aim to understand the process of planetary formation and evolution in the hottest part of the proto-planetary nebula as well as to understand similarities and differences between the magnetospheres of Mercury and Earth.

The baseline mission consists of two spacecraft, i.e. the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO). JAXA is responsible for the development and operation of MMO, while ESA is responsible for the development and operation of MPO as well as the launch, transport, and the insertion of two spacecraft into their dedicated orbits.

MMO is designed as a spin-stabilized spacecraft to be placed in a 400 km x 12000 km polar orbit. The spacecraft will accommodate instruments mostly dedicated to the study of the magnetic field, waves, and particles near Mercury. While MPO is designed as a 3-axis stabilized spacecraft to be placed in a 400km x 1500 km polar orbit. Both spacecraft will be in same orbital plane.

Critical Design Review(CDR) for MMO project is completed in November 2011 while ESA Spacecraft CDR is completed in Novemver 2013. MMO stand alone FM AIV is expected to be finished on early March this year. MMO FM will be transported to ESA/ESTEC on April. After some stand alone activity for MMO, JAXA will handover MMO to ESA to attend stack level (MCS) final AIV. BepiColombo is expected to be launched in summer 2016.

BepiColombo science working team (SWT) meeting, which discusses science related matters, is held once a year. In this paper, BepiColombo project as a test case of large collaboration between ESA and JAXA will be reported.

Keywords: Mercury, Planetary Exploration, International Collaboration

PPS04-08 Room:A03 Time:May 27 15:40-16:00

STRATEGIC MAP FOR EXPLORING THE OCEAN-WORLD ENCELADUS

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Introduction: Cassini's discovery of jets emitting salty water from the Saturn's small moon Enceladus is one of its most astounding results. Measurement of salts and organic species in the resulting plume, finding that tidal stretching at apocrone valves the jet activity, modeled lifetime of E-ring particles, and gravitational inference of a long-lived, large water reservoir in contact with the rock core all indicate that Enceladus meets textbook conditions for habitability: liquid water, biologically available elements, energy source, and longevity of conducive conditions. Enceladus is among the best places in our solar system to search for direct evidence of biomarkers.

Exploring an ocean world: Enceladus also proffers the simplest access by a flight mission to telltale molecules, ions, isotopes, and potential cytofragments, since its plume continuously expresses material from the ocean directly into space. In situ mass spectroscopy of the plume, plume sample return, in situ investigation of plume snow on the surface, direct sulcus and vent exploration, and eventually submarine exploration can all be envisioned.

However, the strategic urgency and feasibility of planning and funding elaborate in situ exploration of this ocean world will hinge on new data revealing promising results. The very first steps of the roadmap are pivotal.

Two straightforward mission concepts, one Discovery-class and one New Frontiers-class, are: flythrough plume analysis using gas and particle mass spectrometers, upgrading the Cassini INMS and CDA measurements but with modern, high-resolution instruments; and collection of plume ice particles, dust, and gas upon Stardust-like flythrough, followed by sample retrieval for comprehensive analysis in terrestrial laboratories.

Building a strategic map: The mission waypoints on an integrated strategic map each require unique capabilities, address focused science questions, and yield results important for setting priorities and making subsequent in-vestments. However, overlaid on this logical sequence are important, mutually competing programmatic constraints: astrobiology pursuits at other ocean worlds and Mars, and exoplanet spectroscopy; cadence of realistic opportunities for mission selections and formal science-community planning cycles via Decadal Surveys; programmatic and even popular impatience to await interim results before vectoring investments in enabling capabilities; and alignment of US exploration strategies with international partner goals. As with Mars for many years, anticipation of interesting eventual results may be a key driver of strategic intent, able to withstand absence of validation for many years. And as for major exploration pursuits like Cassini-Huygens and the International Space Station, synergy among international partners may prove key for establishing and sustaining programmatic intent and momentum.

Key enabling elements for long-term exploration of the ocean-world Enceladus include: coherent sequence of science questions addressable by various type of mission; technologies that mature at the right time to enable both mission performance and approval (e.g., planetary protection); integrated concepts whose cost estimates survive review; lessons learned from analog exploration (e.g., terrestrial oceanography and extremophile research), and community momentum and international partnerships.

Decision levers and opportunities for action: Analysis of these elements of the strategic map yields a short list of decision pressure points for the next two decades. Using these opportunities the community may systematically prosecute the grand objective of finding and exploring an alien ecosystem within the working lifetime of today's graduate students. If missed, however, progress toward an age of comparative ocean exploration will be episodic, haphazard, and slow. Windows for making significant advances are sparse, and much remains to be done to prepare to take advantage of them.

Keywords: Enceladus, ocean world, life, plume, in situ, sample return

PPS04-09 Room:A03 Time:May 27 16:15-16:30

New Challenges in Planetary Protection for International Astrobiology-Driven Explorations

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Planetary protection is an international and interdisciplinary activity among scientific, technological, operational and administrative countermeasures to preserve biospheres of both the Earth and exploration targets, should they have a scientific potential to have one, including Mars and some icy satellites of Jupiter and Saturn such as Europa, Ganymede, Enceladus and Tian. It also deals with all sample return missions to assess risks of each returned sample if they may endanger the terrestrial biosphere, according to a scientifically internationally agreed evaluation process endorsed by COSPAR Planetary Protection Panel, the worldwide authority to which all major spaced agencies follow their compliance.

In the coming decades, deep space exploration will focus on astrobiology-driven missions more than ever. Thus international space exploration community must work closely with the planetary protection issues of following respective missions to make them an enabler, rather than a show stopper.

Mars exploration now faces how to prevent terrestrial contamination at potentially inhabited regions like recurring slope lineae in order to search for direct evidence of indigenous life there. Also human landing and habitation, no matter sortie for the NASA plan or even permanently for Mars One, pauses serious contradiction with robotic life detection missions.

D/P-type asteroids such as the Martian satellites and Jupiter Trojans are now considered to be realistic targets for next generation robotic sample return missions while they still lack definite analog meteoritic samples on the earth, unlike S-type and C-type asteroids. Their present status of the restricted Earth return must be re-evaluated with the most updated scientific knowledge today, before COSPAR will endorse any of these sample return missions.

Sample returns of plume particles from icy bodies are a game changer of deep habitat research. Yet there have been few studies of planetary protection and contamination/alteration control at the sampling, return cruising, earth re-entry and subsequent laboratory analyses.

This presentation explains the above challenges and summarizes current efforts and future prospects how to overcome them.

Keywords: Planetary Protection, Sample Return, Mars, Icy Plumes, D/P-type Asteroids, COSPAR

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Hayabusa 2 and OSIRIS-REx: international collaborations on sample retrun missions

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The Origins Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) asteroid sample return mission was selected by NASA in May 2011 as the third New Frontiers mission. The target, (101955) Bennu, is a B-type asteroid, hypothesized to be similar to CI or CM carbonaceous chondrites. The key science objectives of the mission are summarized in [1] with the major goal of returning pristine asteroid regolith. It is scheduled to launch in September 2016. Hayabusa2 is an asteroid sample return mission to the C-type asteroid, 1999 JU_3, and builds off of the successful Hayabusa mission, the first mission to return a sample from an asteroid. Hayabusa2 launched in December 2014.

The OSIRIS-REx science team is an international team including Co-Is and collaborators from the United States, Canada, France, and the United Kingdom with the Canadian Space Agency contributing an instrument (OSIRIS-REx Laser Altimeter) to the mission [2]. In addition, in November 2014, a Memorandum of Understanding (MOU) was signed between NASA and JAXA for cooperation between the Hayabusa2 and OSIRIS-REX missions. The Hayabusa2 science team is an international team including Co-Is and collaborators from Japan, Germany, France, the United States, Korea, the United Kingdom, Australia, Switzerland, and Italy. A lander MASCOT (Mobile Asteroid Surface Scout) for the Hayabusa2 was developed by DLR and CNES [3].

The official collaboration between the Hayabusa2 and OSIRIS-REx as defined in the MOU presents an important series of challenges for both missions. These challenges focus on sharing data from both science and engineering elements of the mission, including during asteroid operations and, ultimately, sample analysis and actual returned samples. It also provides an opportunity for the two missions to learn about each cultural systems and how both science and engineering are approached from the human element. The two projects will develop a mutually agreed upon Joint Sample Exchange Curation and Analysis Plan that will support the mutual participation of scientist in both missions.

Hayabusa2 and OSIRIS-REx are sample return missions, and the exchange of samples between the two agencies will occur, building on lessons learned from the past. From JAXA, a total of 10% by mass of a representative and unprocessed portion of the returned Hayabusa2 sample will be jointly separated for full transfer to NASA no later than 1 year after Earth return. NASA will deliver a total of 0.5% by mass of the OSIRIS-REx sample no later than 1 year after Earth return and will jointly separate a representative and unprocessed sample. A key challenge for the two missions and agencies will be to determine and agree upon what constitutes a representative sample, in part because any agreed upon criteria for establishing what is representative could inevitably need to be re-evaluated upon sample return do to unexpected results in sampling.

[1] Lauretta et al. (2014) The OSIRIS-REx Target Asteroid 101955 Bennu: Constraints on its Physical, Geological, and Dynamical Nature from Astronomical Observations. Meteorit. Planet. Sci. 49. [2] Dickinson et al. (2012) AN OVERVIEW OF THE OSIRIS REX LASER ALTIMETER OLA. 43rd LPSC 1447. [3] Lange et al. 7th International Planetary Probe Workshop Proceedings, Barcelona, Spain. 2010.

Keywords: OSIRIS-REx, Hayabusa2, Sample Return, Missions, NASA, JAXA

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The Nautilus Space Mission: Unveiling the Origin of the Diversity of the Asteroid Belt and of Earth Water

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We present the Nautilus space mission recently proposed to ESA in the framework of the M4 call. The overarching science goal of the Nautilus mission, proposed by a team of European scientists with a strong participation of US scientists and other international scientists, is to explore a volatile-rich asteroid not represented in our meteorite collections (C- or D-type), and ultimately cast light on these aspects of the early history of the solar system. Its payload will allow performing high resolution imaging, ultra-violet, visible, near-infrared, mid-infrared and microwave spectroscopy, mass spectrometry of the gas phase, magnetic field measurements, and radio science. This proposal is supported by a team of ˜170 scientists that includes prominent, world-class experts of primitive solar system bodies and of space instrumentation. In this presentation, we will highlight the challenges of this space mission and invite broader support from the international community.

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Personal involvement in the international astronomical projects

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International collaboration is the key to lead the large-scale mission to the success. The large-scale project or big-science projects require coordinating multi-country teams and the budget. There are several ways to be involved in such a big project even an individual researcher can join. Here I will present my experiences, individual participation, such as (1) NASA Leonid MAC (Multi-Instrument Aircraft Campaign) which brought ~50 researchers from nine countries together in two aircraft to observe the Leonid meteor storms, (2) Pan-STARRS1 sky survey telescopic project on Mount Haleakala in Hawaii operated by the consortium which was made up of astronomers from 10 institutions from four countries (Japan was not included), (3) Asteroid sample return mission Hayabusa and so on.

Keywords: Asteroids, Comets, Meteors, International projets

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PPS04-13 Room:A03 Time:May 27 17:15-17:30

Telescopes Dedicated to the Observations of Planets and Exoplanets at Haleakala, Hawaii

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[1]Tohoku Univ., [2]IfA, Univ. Hawaii, [3]Kiepenheuer Institute for Solar Physics

In this paper, we introduce the University-sized small but unique telescope project at the summit of Mt. Haleakala of Maui Island, Hawaii.

Clear sky and good seeing condition are definitely important for any ground-based observations. The Haleakala High Altitude Observatories at the summit of Mt. Haleakala is not the highest place (3050m), but one of the best sites with clear sky, good seeing, and low humidity conditions. Operation is relatively easy because we can access to the airport, major towns, and a good engineering facility, ATRC (Advanced Technology Research Center) of IfA/UH within 1-2 hour drive from summit.

On the summit, our group has been operating a 40 cm Schmidt-Cassegrain telescope (T40), observing faint atmospheric features such as Io torus, Mercury, Lunar sodium tail, and so on. From fall 2013, ISAS Hisaki/Exceed EUV space telescope run on the orbit. The T40 telescope has uniquely provided long-term Io torus activities for this project. T40 will also link to Juno mission that will start Jovian observation from 2016.

Atmospheres and its escapes from planets and exoplanets are next extensions. From the late 2000s, we started the project to develop the telescope dedicated to planets and exoplanets, under the international consortium formed with IfA/UH and several groups in USA, Mexico, Canada, and Europe. This telescope project consists of several parts: The main is the new construction of the 1.8m off-axis telescope named PLANETS.

Associated with this project, we also moved our 60 cm telescope (T60) from Tohoku Univ. Iitate Observatory, and started the operation from Sep. 2014. T60 is equatorial-mount Cassegrain telescope. By the acceptance of this move by IfA, we adjusted its mount angle to the Hawaiian latitude, and moved to Haleakala in spring of 2014. This telescope can observe infrared light covering many molecular lines in planetary atmospheres. This telescope has Coude focus that can allow relatively large-sized instruments. Using this feature, our telescope is now providing the first capability of long-term operation of Infrared heterodyne spectrometer (MIRAHI) developed by us. It can achieve the spectral resolution of ˜107, and resolve the atmospheric lines behind the terrestrial absorption lines and atmospheric velocity field in several 10 m/s resolutions. With other instruments, Venus, Mars, and Jupiter observations are planned in 2015. They will be linked to the observations of orbiter projects like Mars Express, MAVEN, Mars Trace Gas orbiter for Mars and Akatsuki for Venus, like T40 linked to Jupiter.

The 1.8m PLANETS (Polarized Light from Atmospheres of Nearby Extra Terrestrial Planets) telescope will have the first light in 2016 in the earliest case. It has an off-axis primary mirror (provided from Tohoku Univ.) with a diameter of 1.8 m. By the telescope structure optimization, we can avoid diffraction due to a spider structure that holds a secondary mirror and to minimize the scattered light from mirror surfaces as far as possible. With the instruments set to Gregorian focus on an equatorial mount, it can provide us a unique facility for spectroscopic and polarimetric observations of faint environments around the bright bodies, like planetary environments, stellar disks, etc.

T60 has also equatorial mount, and provides a test bench of instruments for PLANETS. One of examples is the exoplanet polarimetric instrument 'DiPol2', which tries to detect the reflected polarized light from exoplanet in the non-polarized mother star continuum. This test run was also from Jan 2015.

It is welcomed to any planet and exoplanet observation scientists who have interest to use our facility or expect to attach their own instruments for specific objectives. For promoting such activities, M. Kagitani, H. Nakagawa, and M. Yoneda stay in or visit frequently to Maui, and are contributing to the telescope/instrumental operations and developments.

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International Cooperation in NAOJ Mizusawa : Result of Kaguya, and possibility in the future.

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In the Japanese lunar explorer SELENE (Kaguya), which was launched on September
14th, 2007, VLBI observations were made for the purpose of improvement of the lunar gravity field model, through an international network as well as Japanese VERA (VLBI Exploration of Radio Astrometry) network. The international network consists of Shanghai and Urumqi (China), Wettzell (Germany)and Hobart (Australia) stations. They participated in VLBI observations, data reduction and data analysis based on the MOU for cooperative research, and the cooperation contributed not only to the success of Kaguya mission but to produce more scientific results.

RISE project of NAOJ (National Astronomical Observatoryof Japan) were continuing the cooperation with Shanghai Astronomical Observatory, Xinjian Observatory (China) and Kazan Federal University (Russia) before Kaguya mission in the field of space geodesy, selenodesy, geodynamics and geophysics, astronomy and astrophysics. The International Earth Rotation and Reference Systems Service (IERS) which Mizusawa observatory contributed for long years is one of the basis of these cooperative researches. These cooperative researches are continuing for future lunar and planetary missions by exchange researchers and students and having international meetings.

Keywords: International cooperation, MOU, VLBI, Earth rotation, Space geodesy, Lunar mission