

Activity Report of Commission J
April 26, 2019 to September 18, 2020

September 30, 2020

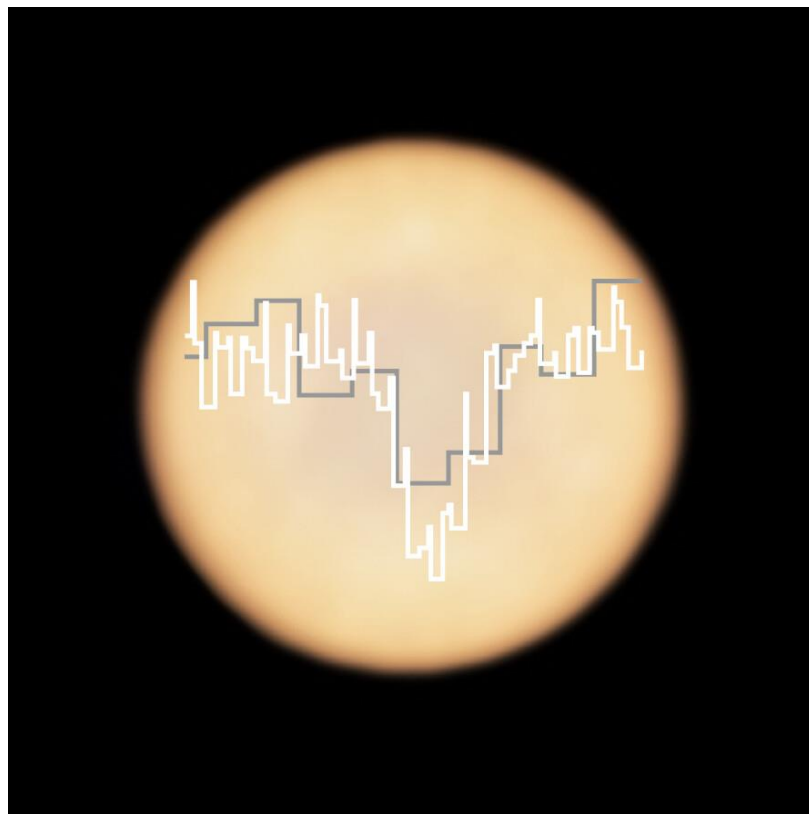
Kenta Fujisawa (Yamaguchi University)

ALMA project

- ALMA press release (September 15, 2020)

Phosphine on Venus - A step forward to understand biomarker molecule

An international team of astronomers detected phosphine (PH_3) in the atmosphere of Venus. They studied the origin of phosphine, but no inorganic processes, including supply from volcanos and atmospheric photochemistry can explain the detected amount of phosphine. The phosphine is believed to originate from unknown photochemistry or geochemistry, but the team does not completely reject the possibility of biological origin. This discovery is crucial to examine the validity of phosphine as a biomarker.



ALMA image of Venus, superimposed with spectra of phosphine observed with ALMA (in white) and JCMT (in grey). As molecules of phosphine float in the high clouds of Venus, they absorb some of the millimeter waves that are produced at lower altitudes. When observing the planet in the millimeter wavelength range, astronomers can pick up this phosphine absorption signature in their data as a dip in the light from the planet.

Credit: ALMA (ESO/NAOJ/NRAO), Greaves et al. & JCMT (East Asian Observatory)

Activities of meetings

- **International Workshop on EAO Futures: Future Science and Instrumentation**

Date: Mar 20th-23rd, 2019

Location: Najing, China

May 20th - 23rd 2019 the East Asian Observatory will host a four day (two half days and two full days) meeting looking at the future of science drivers and instrumentation needs of Sub-mm EAO astronomers. The meeting will discuss a range of topics including the Namakanui instrument at JCMT, the design of a new 850 micron camera for use at the JCMT, the East Asian VLBI project, and instrumentation in polar climates. Talks will cover both the technology involved in these programs and the science cases for such instrumentation.

- **The 10th Galactic Center Workshop (GCWS 2019): New Horizons in Galactic Center Astronomy and Beyond**

October 21 (Monday) to 24 (Thursday), 2019 (Reiwa 1)

Keio University Hiyoshi campus

The central few hundred parsecs of the Milky Way Galaxy, which is often referred to as the central molecular zone (CMZ), is characterized by a strong concentration of stars and interstellar matter. Many surveys in various wavelengths, from radio to gamma-rays, as well as pointed observations have revealed a variety of astrophysical phenomena, most of which remain elusive: i.e., the three-dimensional distribution of gas; suppressed star formation despite the abundance of dense molecular gas; a currently inactive supermassive black hole but rich signatures of past central activities, the high-energy diffuse gamma-ray emission from GeV up to TeV energies, etc. These unsolved issues span wide ranges of spatial scale, time scale, and energy scale and are likely related to each other. Current key issues in Galactic center studies include: (1) the triggering mechanism of central activity; (2) the formation process of the central supermassive black hole; (3) existence proof of the supermassive black hole at Sgr A*; (4) star formation properties in the CMZ; and (5) the properties of stellar remnants and their binaries, which would be gravitational wave progenitors. These issues are common to studies of extragalactic nuclei.

- **Nobeyama Science Workshop Reiwa 1st**

Date: 2019/9/4-6

Location: Nobeyama Radio Observatory

The Nobeyama 45m radio telescope has been playing an active role as the leading telescope in Japanese radio astronomy since 1982. Since then, it has brought many important results, but due to changes in the environment and needs, open use observation will be finished by March 4th year of this year. It even gives the impression that the science itself with single-dish is shrinking. However, many active users are young researchers who will lead the next generation.

This workshop provides a place for users to gather and discuss about the latest achievements and research prospects, and to think about the possibilities of science with a single-dish in the new era.

- **Galactic Center Workshop 2019**

Date: 2019/6/10

Location: Nagoya University

The galactic center is a unique region of the galaxy where stars and gases are densely packed. The gas in this region shows non-circular motion at high temperature and high density with large velocity dispersion. Further, it is said that the magnetic field strength in the central portion is one order of magnitude higher than that in the disk region. Research on the star formation process in such a peculiar environment is an important subject of star formation research. In recent years, sensitive X-ray and gamma-ray observations have revealed several outflow-like objects that blow out from the center to the north and south. Therefore, it can be said that the closest core, the center of the galaxy, is the most important target for understanding the evolution and activity of the core. In order to study interstellar phenomena and core activity in such a strong magnetic field environment, theoretical approaches such as magnetohydrodynamic calculations are indispensable. In this study group, observation researchers and theoretical researchers from various wavelengths and research fields will meet together to provide a place for concrete and close discussions with a view to future observation equipment.

- **The 12nd East Asia VLBI Workshop**

Date: Sep 24 - Sep 26, 2019

Location: Mito Campus, Ibaraki University

Since the release of the first EAVN call for proposal in April 2018, the EAVN array is now in its real operation with 10 stations (KaVA, Tianma, Nanshan and Nobeyama). The EAVN-2019 will be the first meeting after this milestone, while an increasing number of exciting results are coming out with KaVA, the core array of EAVN. We will discuss and highlight various science topics studied by EAVN/KaVA as well as by individual VLBI facilities VERA/KVN/CVN/JVN. This will include active galactic nuclei, star formation, evolved stars, astrometry, micro quasars, pulsars, transients, multi-messenger science etc. We will also highlight various ongoing developments of the array capability and instruments as well as the near-future expansion of the network into Ibaraki, Yamaguchi, Kunming, Thailand, Italy, Australia etc. Moreover, the VLBI community in East Asia is increasingly involved with EHT and SKA. Therefore, we will also discuss how EAVN can play a unique role in the era of such huge facilities. This will include "EAVN-high" that includes JCMT/GLT and "EAVN-low" that includes FAST, as well as joining a global VLBI network.

- **The 1st circular of the next generation VLA workshop**

Date: September 17-20, 2019

Location: NAOJ, Mitaka, Japan

The next generation Very Large Array (ngVLA) project, which is led by the National Radio Astronomy Observatory in the USA, is one of the most ambitious on-ground radio astronomy projects for the next decades. This new on-ground cm/mm-wave radio telescope will be composed of 214 18-m antennas placed around the current VLA site in New Mexico and extending into other states in the US, and even into Mexico, complemented with a short baseline array composed of 6-m and Total Power antennas, and a long baseline array extending from Hawaii to the US Virgin Islands. This will provide a large collecting surface with baselines up to 9000 km, which will translate into unprecedented sensitivity and milli arcsecond angular resolution at frequencies from 1.2 to 116 GHz.

- **The 17th IVS NICT-Technology Development Center Symposium**

Date: 2019/6/27

Location: NICT Kashima Space Center

We will hold a symposium on research and development of VLBI technology and space geodesy technology, so we would like to invite you to participate. In the field of geodetic VLBI, IVS (International VLBI Service for Geodesy & Astrometry), which leads the international geodetic VLBI, is a next-generation wideband geodetic VLBI system that enables ultra-wideband observation of 2-14 GHz. (VGOS) is being promoted, and countries around the world (US, Germany, Spain, Japan, Russia, China, South Africa, Norway, etc.) have installed new antennas and observation systems, and observations have begun. NICT has developed a 3-14GHz wideband VLBI observation system along with the guideline of VGOS, and is conducting international observations of intercontinental frequency comparisons using wideband small antennas. At the symposium, we would like to exchange information on VLBI technology, space surveying technology such as GNSS, SLR, single radio telescope observation, time / frequency related technology, and observation results, aiming for further development of the VLBI field.

- **EA ALMA Development Workshop 2019**

Date: December 10-11, 2019

Location: Large Seminar Room, NAOJ, Mitaka

The Atacama Large Millimeter/Submillimeter Array (ALMA) is now routinely producing groundbreaking scientific results in almost all fields of astronomy and astrophysics. In order to maintain ALMA as the most advanced (sub)mm-wave array in the coming decades, all ALMA partners are now striving to realize the goals presented in the ALMA Development Roadmap. The East Asian ALMA has been holding the EA ALMA Development Workshop every year, with the main aim to present the latest technological advancement and exchange

ideas which are relevant to the upgrade of ALMA. This annual workshop is intended to become an effective forum for interaction and discussion between the technical and scientific communities, and the input from the community is key in the establishment of the EA ALMA Development Program. Last year, the main focus of the workshop was “wide IF”, which is recognized as the highest priority in the ALMA Development Roadmap. This year, we would like to invite talks and discussion related to high frequency (bands 8, 9 and 10) observations of ALMA and related hardware and software development. Apart from this major focus, we will welcome contributions in the fields of antennas, front-ends, back-ends, and software development and related talks in science, science operations and/or commissioning of new capabilities.

- **Sub-mm Spectroscopy and Large-Scale Science with ASTE**

Date: 2019/08/19 10:30-17:30

Place: Lecture Room at NAOJ Mitaka Campus

ASTE is a 10-m class submillimeter-wave single-dish telescope which enables to carry out large programs and surveys with its operational flexibility and superb atmospheric conditions. There are demands on large scale [CI] and CO (3-2) and (4-3) mapping of the Galactic Center region, Galactic Plane, molecular clouds in the far outer galaxy, high-latitude molecular clouds, LMC/SMC and local group galaxies.

ASTE also serves as a test bench of astronomical instrumentation to explore new areas of technology with an expected positive impact on science. DESHIMA (Deep Spectroscopic High-redshift Mapper) is a new type of submillimeter wave spectrometer, which uses a superconducting filterbank on a chip to achieve a very wide instantaneous bandwidth. DESHIMA prototype was installed on the ASTE in 2017 and has successfully detected multiple astronomical sources, in both continuum and line emission. In this year, installation and commissioning of a new receiver with ALMA Band 10 frequency coverage (787-950 GHz) is planned including pilot observations to obtain [CI] (2-1) and CO (7-6) and (8-7) lines.

Therefore, there is no doubt that ASTE can proceed its own unique science in the ALMA era. The main objective of this workshop to discuss and identify future Sub-mm Spectroscopy and Large-Scale Science with ASTE by our community members. We look forward to the participation by researchers who are interested in sub-mm astronomy and related fields.

- **2019 ALMA/45m/ASTE Users Meeting**

Date: December 18 - 19 (Wednesday - Thursday), 2019

Location: National Astronomical Observatory of Japan (Mitaka Campus, Subaru building 1F large seminar room)

- **General Meeting of Japan Radio Astronomy Forum**

Date: 9/11, 2019

Location: Kumamoto University

- **VLBI Consortium Symposium 2019: VLBI Crosses National Borders**

Date: 2019/11/23-25

Location: Otsuma Women's University

The VERA project, which has been the core of Japan's astronomical VLBI observations, has reached the stage of compiling the results, the number of users of EAVN, in which VERA / JVN, Nobeyama, South Korea, and China participate, is increasing, and results are being produced. Joint experimental observations with Italy are under active research in both astronomy and geodetic / time transmission VLBI. A Japanese group also contributed to EHT, which is a large-scale international joint research, and succeeded in shooting a black hole shadow. A 230GHz VLBI experimental observations in East Asia are also being conducted through joint research by Japan, Taiwan, South Korea, and China. SKA, which is closely related to VLBI, is about to start construction. It can be said that international VLBI collaboration is now providing a new research framework. Research themes have expanded from classic AGN jets and maser to accretion disks, transient objects, black holes in the galaxy, and further expanded into new areas of multi-messenger astronomy and time domain astronomy through multi-wavelength collaboration. At the VLBI Consortium Symposium 2019, we plan to focus on discussions aimed at building a new research framework through international collaboration, entitled "VLBI Crosses Borders." The purpose of this is to draw out new research themes of the VLBI community and discuss and share the future image.

- **17th Mizusawa VLBI Observatory Users Meeting in 2019: 1st circular**

Date: December 13 - 14, 2019

Location: Mizusawa VLBI observatory, NAOJ

Mizusawa VLBI Observatory has proceeded astrometric observations with VERA to unveil 3-D spatial/velocity structures in the Milky Way Galaxy and its dynamical evolution. On the basis of the activity, we have accelerated a development of KaVA (KVN and VERA Array) and EAVN (East-Asian VLBI Network). As a result an open-use of EAVN has been initiated since 2018B semester (observations will be allocated from 2018 September). From 2019B semester, astrometric mode of KaVA open-use has been opened. We emphasize that the development of EAVN will promote the KaVA Large Programs in research fields of Star, AGN, and High-mass star formation, which have been initiated since 2016. On the other hand, Budget cut for Mizusawa VLBI Observatory will be expected based on the long term plan of NAOJ management. It is necessary that we discuss with community members how efficiently we conduct observational research in such situation. Based on that situation, we will discuss about not only exciting scientific results with VERA/KaVA/EAVN but also future prospects of Mizusawa VLBI Observatory especially in 2022 and beyond. EAVN will be further developed on the basis of future collaborations with JVN (Japanese VLBI Network), FAST 500-m (China),

and TNRT 40-m (Thailand) radio telescopes, leading improvement of sensitivities and observable frequencies; Synergy with Gaia DR2 and SKA has been expected.

- **The ALMA Workshop: Early Planet Formation in Embedded Disks**

Date: December 8-10, 2019

Location: University of Tokyo.

Previous high-resolution ALMA observations of protoplanetary disks around Class II sources, such as DSHARP, have shown that substructures in those disks are ubiquitous, mostly in the form of concentric rings and gaps, implying the presence of planets in these disks. The ubiquitous detection of substructures in protoplanetary disks raises the intriguing possibility that at least some planet formation may have started already during the embedded stages of protostellar evolution. In order to address exactly how and when planet formation might begin, we will start an ALMA large program to systematically observe a large sample of Class 0 and I objects with an angular resolution of 0.04" (5 au) in 1.3 mm dust continuum and CO emission lines at 230 GHz to investigate how early substructures indicative of planet formation arise in disks in the evolution of young stars. In the workshop, we will invite several overseas experts in this field, and will review recent observations of disks around protostars as well as class II sources. We will also discuss data analysis technique of disks at high angular resolutions, and strategy how to understand possible early planet formation in embedded disks.

- **New View of the Universe opened by THz Observation**

Date: 2019/12/21

Location: National Institute of Polar Research

The terahertz band, which is the new horizon of ground observation, is an undeveloped area and is expected to develop significantly in the future. Currently, site survey and equipment development are underway to open up terahertz astronomy. The purpose of this study group is to discuss what kind of new science can be developed by utilizing the terahertz band, which is the only wavelength region that large terrestrial telescopes have not been able to reach.

- **Molecular gas observations toward the Local Group and the outer Milky Way**

Date: 2020/1/16 – 17

Location: Nagoya University

Research of the formation and evolution of astronomical objects (molecular gas, stars / clusters, galaxies) from the early universe to the present is one of the greatest challenges in astronomy. The outer edge of the galaxy is an optimal target that can cover parameter spaces that cannot be filled by the system alone with high-resolution observations. In particular, observations of low heavy-element content environments are very useful for understanding the formation and evolution of celestial bodies in the early universe. From recent observations of the large Magellan cloud and M33, gas motion on the kpc scale due to galaxy interaction and spiral arm

motion may create a molecular cloud filaments width of about 0.1 pc. The possibility of inducing formation is being clarified, and it is rapidly becoming more important to have a bird's-eye view of the entire galaxy with a high spatial dynamic range using multiple devices such as ALMA. Observations of outflows to primordial stars and surveys of hot cores are also being energetically advanced, and it is expected that statistical verification of the physical / chemical properties of massive star formation in low-heavy element environment will progress.

- **ALMA Grant Fellow Symposium 2019**

Date: December 17, 2019

Venue: NAOJ Lecture Room

The NAOJ ALMA project will host the “ALMA Grant Fellow Symposium 2019” on December 17, 2019 at the NAOJ Lecture Room in Mitaka. The symposium will host 12 researchers hired through the ALMA Joint Scientific Research Program, and they will be presenting the latest science results related to ALMA. Anybody is welcome to join and hear the talks.

- The ALMA 2030 Vision: Design considerations for Digitizers, Backend and Data Transmission System

Date: March 11-13

Location: NAOJ, Mitaka, Japan

The ALMA Development Roadmap has identified the multiplication of the IF bandwidth of ALMA (at least by a factor 2) as one of the main priorities for ALMA upgrades in the 2020s. This increase of the instantaneous bandwidth will be realized with the coordinated upgrade of receivers in the Front End, the correlators, and last but not least, all electronics between them: digitizers, backend and Data Transmission System (DTS). This meeting aims to bring together experts on the ALMA system and digitizer, backend and data transmission system technologies, from within ALMA and from the community.

<<<CHANGED TO VIRTUAL MEETING, OCTOBER 14-16, 2020>>>

- **6th Riken-NICT THz Workshop & 20th Millimeter-Submillimeter Receiver Workshop**

Date: 2020/3/2 – 3

Location: Tohoku University

- **Star formation with ALMA 2020: Tracing pre/proto-stellar core evolution in nearby molecular clouds**

Date: March 5 (Thu) 13:00- 6 (Fri) 17:00, 2020

Venue: Rinko-shitsu (C5-112), NAOJ Mitaka campus

Understanding the origin of diversity in star formation, from the initial mass function to the size and structures of protostellar disks, is one of the ultimate goals in star formation studies. Such diversity should be originated from the natal dense cores. Observational studies of such dense

cores harboring Class 0/I objects, i.e., protostellar cores, or even cores before protostellar formation, prestellar cores, should provide us with crucial information on the initial condition of star formation. However, previous ALMA observations have not extensively explored such young objects but mainly targeted well-known protostellar and T-Tauri sources, which were discovered before the ALMA era using, e.g., other wavelength telescopes and low-resolution mm/sub-mm single-dishes. ALMA has the potential to improve this situation; for example, recent ALMA surveys, including the ACA (Atacama Compact Array) stand-alone mode, are trying to find new exciting objects without any bright infrared sources, such as candidates of the first hydrostatic core. Although single-dish telescope and other wavelength data still play an essential role as the first atlas, the era that ALMA itself can be one of the survey telescopes is likely upcoming. In this workshop, we will discuss the observational strategies on how to select the target objects using ALMA and to optimize the subsequent follow-up observations to reveal the initial condition of star formation, also by combining with the related theoretical simulation.

<<<CANCELLED>>>

- **Dynamics and physics of outflows in protostellar disks and Active Galactic Nuclei II**

Date: 2020/3/23 – 25

Location: Kagoshima University

- **Japan Radio Astronomy Forum Symposium 2019: Radio astronomy that opens up with extreme performance**

Date: 2020/3/23 – 25

Location: NAOJ, Mitaka

The Japan Radio Astronomy Forum is an organization that represents the Japanese radio astronomy community. As part of its activities, a symposium is held every year for the purpose of sharing the science and observation technology of radio astronomy and discussing future plans. At the symposiums of the last two years, we have held multifaceted discussions over two days, focusing on technological development that will support future radio astronomy and future science in collaboration with other wavelengths and fields. Based on these results, this year, we will focus on various "extreme performances" regardless of projects and existing telescopes, and explore science that can only be done by radio astronomy and new methods to realize it in the entire community.

<<<CANCELLED>>>

- **New Developments of Planetary Sciences with ALMA in JpGU-AGU Joint Meeting 2020**

Date: 27 May, 2020

Location: Makuhari Messe in Chiba

We would like to invite contributed talks for the session of "New Developments of Planetary Sciences with ALMA" in JpGU-AGU Joint Meeting 2020 held on 27 May, 2020, at Makuhari

Messe in Chiba. It has been about 5 years since the series of concentric rings has been discovered in the protoplanetary disk of HL Tau, and we will review the current understanding of planetary-system formation in our session. Recent results with ALMA on the Sun, solar-system planets, and extra-solar planetary systems will be presented and discussed among researchers in planetary science and astronomy.

- **ALMA Lensing Cluster Survey Workshop**

Date: March 13 - 14, 2020

Location: Institute of Astronomy (IoA), University of Tokyo

ALMA lensing cluster survey (ALCS) is one of the cycle-6 large programs to observe high magnification regions of 33 lensing clusters spending 95 hrs. The ALCS covers 88 arcmin² in total, to a depth of ~60 μ Jy (1.2mm, 1 sigma), achieved by using a 15-GHz-wide spectral scan, to enlarge the survey volume of line-emitting galaxies. The sample comes from the best-studied massive clusters also imaged in HST programs, i.e., CLASH, HFF, and RELICS. The goals of the workshop are (1) to share the latest outcomes from ALCS and ALMA observations of blank fields, clusters/proto-clusters, and high-redshift lensed galaxies, and (2) to develop next ALMA (large) proposals and related multi-wavelengths follow-up plans using e.g., JWST. You are encouraged to join if you are interested in any of the topics below.

<<<CANCELLED>>>

- **IAU Symposium 360: Astronomical Polarimetry 2020 -- New Era of Multi-Wavelength Polarimetry**

Date: March 23 -- 27, 2020

Location: Hiroshima, Japan

Astronomical Polarimetry 2020 (Astropol 2020) is the next in a series of international conferences. The aim of this series of conferences is to bring researchers interested in astronomical polarimetry together to share and discuss recent results and advances in technical and scientific aspects in all relevant astronomical fields. This will be the first time that an Astropol symposium will take place in Asia.

<<<POSTPONED TO 2021 March 22-26>>>

- **SNR Workshop 2020**

Date: February 26-27, 2020

Location: Nagoya University

Supernova remnants (SNRs) are the most energetic objects not only in our Galaxy, but also in external galaxies, and have been observed at various wavelengths from radio to gamma-rays. One of the most spectacular features of SNRs is the fast moving expanding shells whose velocity is measured as up to ~10,000 km/s. Recent observations of shells in X-rays as well as radio continuum emission have provided a wealth of information on their physical and

kinematical properties. It is also remarkable that the dense interstellar medium interacting with the shocks is likely playing a key role to produce X-rays and gamma-rays as shown by comparisons with CO/HI and dust emission. Theoretical works on acceleration and escape of cosmic rays in SNRs are unveiling details of cosmic-ray acceleration/propagation by magneto-hydro-dynamical numerical simulations, which will be compared with observations. In the present workshop, we invite observers and theorists to stimulate active interaction and exchange of ideas on SNRs.

<<<CANCELLED>>>

- **Workshop on Carbon Observations - Toward understanding how to use Carbon -**

Date: March 25-26, 2020

Venue: The University of Tokyo

Atomic carbon observations have been started by using the Mt.Fuji Submillimeter-wave telescope in Japan. They have continuously been carried out by using ASTE and are now progressing toward various targets by using ALMA. In this workshop, we will share the recent results of carbon observations in galaxies, interstellar medium and star/planet formation, and also share the related theoretical studies. In addition, we would like to discuss a strategy for the usage of ALMA Band 8 and 10.

<<<CANCELLED>>>

- **IVS NICT Technology Development Center Symposium**

Date: 24-25 April 2020

Venue: Kashima Space Technology Center of NICT

Since IVS (International VLBI Service for Geodesy and Astrometry) was established, NCIT (former name CRL: Communications Research Laboratory) has been designated as one of the technology development centers (TDCs) of IVS. As one of the activities of TDC, we have regularly organized NICT-TDC symposium. Purpose of the symposium is exchanging information on activities and status on research & developments of VLBI technology, application, and radio observing techniques among individual researchers and institutes. In this time, meeting is going to be held as the international symposium with inviting IVS chairman Axel Nothnagel, Network station Coordinator Ed Himwich, Weimin Zheng and Fengchun Shu of Shanghai Astronomical Observatory, and Kosuke Heki of Hokkaido Univ. We encourage contribution not limited only VLBI technology but also observational results on geodesy and radio astronomy, status updates of radio telescope, observing system, and data processing system.

Closing Ceremony of Kashima 34m Antenna

Kashima 34m antenna was damaged by typhoon No.15(Faxai) on 9th Sep. 2019, and main reflector panels are removed in the same month to avoid extension of damage to surroundings by next coming typhoons. Dismantle of the Kashima 34m antenna was decided to be performed

in 2020 not only by this damage, but also due to degradation of the multiple components of the antenna. We will have closing ceremony of Kashima 34m station in the afternoon of 25th April. Please feel free to contact LOC for inquiry on this ceremony.

<<<CANCELLED>>>

- **ALMA Cycle 8 Proposal Preparation Workshop on March 26**

Date: Thursday, March 26, 2020, 11: 00-17: 00 JST

Place: ALMA Building 1F Room102 at National Astronomical Observatory of Japan, Mitaka Campus

A Call for Proposals on ALMA Cycle 8 (Main Call) will be issued on March 17 and the deadline for proposal submission will be on April 15, 2020. East Asia ALMA Regional Center (EA-ARC) will hold a Proposal Preparation Workshop for the ALMA Cycle 8 Main Call at the Mitaka Campus of National Astronomical Observatory of Japan on March 26. The morning session consists of explanatory talks such as on the schedule, new capabilities, Observing Tool for proposal preparation and submission for the Cycle 8 Main Call. The afternoon session focuses on the proposal writing with lectures on the tips to write competitive proposals based on the current writing style in EA. In addition, participants bring their own draft proposals and work on improving them with experienced tutors and an English editor in the hands-on session. We would like to recommend participants to roughly finish up the draft proposals before joining this workshop.

<<<SCALE DOWN, REMOTE MEETING>>>

- **General Meeting of the Japan Radio Astronomy Forum**

Date: 3/17, 2020

Remote Meeting

- **ngVLA Science Working Group Kick-off Meeting**

Date: 2020/3/31

Remote Meeting

- **ngVLA Sub-working Group for Planetary Formation and Proto-planetary Disk, 1st Meeting**

Date: 2020/5/25

Remote Meeting

- **ngVLA Sub-working Group for Black Hole Formation and Evolution, Time-domain/Multi-messenger Astronomy**

Date: 2020/5/28

Remote Meeting

- **ngVLA Sub-working Group for Galaxy Evolution in the Cosmic History, 1st Meeting**
Date: 2020/6/2
Remote Meeting

- **ngVLA Sub-working Group for Star Formation and Astro-chemistry at Multiple Layer**
Date: 2020/6/11
Remote Meeting

- **Technology for Next Generation Space-Earth Environmental Radio Science, a workshop by ISEE**
Date: Wednesday 26 and Thursday 27, August, 2020
Venue: Full remote conference using the Zoom system

Low frequency radio observations are used as one of the main research tools in space-earth environmental sciences and astronomy. Low-frequency radio observation devices are able to effectively obtain a large collecting area and a wide field of view by forming an array with many antennas. Indeed, there are such large radio telescopes and radars for space-earth environmental sciences. In radio astronomy, transient science attracts much attention due to the discovery of fast radio bursts, along with developments of new generation receivers such as ASKAP's PAF and Parkes' UWL. The construction of the world's largest low-frequency radio interferometer, SKA, will start in 2021. Phased arrays and wideband receivers are very common and applicable technologies that benefit various research fields such as space science, geophysics, astronomy, meteorology, and so on. Meanwhile, such technologies have been developed in each field due to a historical background. Moreover, new problems such as radio frequency interference (RFI) and high data rate signal processing emerged along with the improvement of receivers. Therefore, in this conference, we invite experts of developing low-frequency radio instruments across research fields. We aim to provide exchange of the latest development information, clarify common technical elements and problems, and conduct interdisciplinary joint research and collaboration.

- **ngVLA Sub-working Group for Planetary Formation and Proto-planetary Disk**
Date: 2020/8/12
Remote Meeting

- **ngVLA Sub-working Group for Star Formation and Astro-chemistry at Multiple Layer**
Date: 2020/9/1
Remote Meeting

- **ngVLA Sub-working Group for Galaxy Evolution in the Cosmic History, 1st Meeting**

Date: 2020/6/2

Remote Meeting

- **ngVLA Sub-working Group for Testing Gravitational Theories by Galactic Center Pulsars**

Date: 2020/9/3

Remote Meeting

- **ngVLA Sub-working Group for Black Hole Formation and Evolution, Time-domain/Multi-messenger Astronomy**

Date: 2020/9/3

Remote Meeting

- **General Meeting of the Japan Radio Astronomy Forum**

Date: 2020/9/10

Remote Meeting