# Abstract Book

## 2018 Radio Telescope User's Meeting

## 2018 Aug. 16-17, KASI

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edited by H. Kim & G. Park

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## Korea ALMA Project Report

*A-Ran Lyo (KASI),*
*Jihyun Kang, Jongsoo Kim, Sujin Kim, Woojin Kwon, Jung-Won Lee, Bangwon Lee, Se-Heon Oh, Jan Wagner, Kijeong Yim*

Since the Cycle 2 proposal call in 2013, it has already past more than 5 years. In my talk, I will summarize the ALMA proposal and publication statistics. The total number of proposals submitted to Cycle 6 has been increased to 49 compared with 32 for Cycle 5. The development project of the GPU spectrometer for the ALMA total power Array was approved by the ALMA board. The GPU spectrometer has obtained successful spectra from the KVN (Korean VLBI Network) Yonsei antenna and Nobeyama 45m antenna. I will also briefly mention the recently published ALMA 2030 roadmap.

Session: ALMA & the related

## Star formation in the era of ALMA

*Jeong-Eun Lee (Kyung Hee University)*

The unprecedented resolution and sensitivity of ALMA reveal interesting features associated with star formation. Resolved images of protostellar binaries and their disks play an important role in our understanding of binary formation mechanism. In addition, the rich molecular spectra toward protoplanetary disks provide a unique window for the study of chemical compositions of planet forming zone. I will present some interesting results from our ALMA programs from Cycle 2 to Cycle 5.

Session: ALMA & the related

## Environmental conditions in the Lambda Orionis cloud

*Hee-Weon Yi (Kyung Hee University),*
*Jeong-Eun Lee, Tie Liu, Kee-Tae Kim*

We present 1.1-mm and 1.3-mm continuum observations of 6 low-mass young stellar objects (YSOs) in the λ Orionis cloud obtained with the Submillimeter Array (SMA) with ~3.0'' resolution and ~0.3 mJy rms sensitivity. For 4 objects, one component was found in each object at 1.1-mm and 1.3-mm continuum. For G196.92-10.37, dust continuum emissions show two components but for G200.34-10.97S, only 1.3-mm dust continuum show two components.

To derive dust emissivity spectral index (β), we smooth 1.1-mm SMA maps to a resolution of 1.3-mm SMA data. We determine β in the range 0.5 to 2.1, which suggest that the λOrionis cloud was initially very dense, resulting in vigorous grain growth. In our previous study, a mean value of β in the Orion A and B clouds are close to 2, while β in the λ Orionis cloud is much smaller, at 1.65. In this study for 6 YSOs, the mean value of β is 1.20, which is consistent with the SCUBA-2 result.

Session: ALMA & the related

## ALMA Methanol Maser Polarimetry toward a Massive Star Forming Region, G10.34-0.14

*Ji-hyun Kang (KASI),*
*Do-Young Byun, Kee-Tae Kim, Jongsoo Kim, Aran Lyo, Woojin Kwon (KASI)*
*Mi-Kyung Kim (NAOJ), Wouter Vlemmings, Boy Lankhaar (Onsala Observatory) and Gabriele Surcis (INAF-Cagliari)*

We present the preliminary results of the full polarization ALMA observations of the 95 GHz Class I methanol maser transition line toward a massive star forming region, G10.34-0.14. The ALMA data show three mm continuum sources in this region. We identified about 30 maser features together with the 20000 AU-sized thermal methanol outflow. Some strongest masers show a few percent of linear polarization. Their polarization properties are consistent to the VLBI polarimetric observations performed with the KVN telescope, in spite of two orders of magnitude scale differences, indicating that the masing regions have consistent magnetic field environments over these scale lengths (6 AU to 600 AU).

Session: ALMA & the related

## ALMA 최신 결과 발표 및 JCMT large program 업데이트

*Aeree Chung (Yonsei University)*

TBA

Session: ALMA & the related

## HI Observations of Galaxies in the Filaments/Groups around Virgo

*Hyein Yoon (Yonsei),*
*Aeree Chung (Yonsei), Chandreyee Sengupta (Yonsei), O. Ivy Wong (ICRAR/UWA), Martin Bureau (Oxford), Soo-Chang Rey (CNU), Jacqueline van Gorkom (Columbia)*

We present the results of an HI imaging study of 14 late-type galaxies in two large-scale filaments and one infalling group around the Virgo cluster. Using the HI data obtained with the WSRT, GMRT and JVLA (124-hour observation), we aim to probe how galaxies may get pre-processed by the intergalactic medium and/or neighbors in the filaments/groups before entering high-density environments. Based on the detailed HI morphology and kinematics, we present the evidence for gas accretion, ram pressure stripping and tidal interactions that our galaxies are potentially experiencing in the low-density environments. In addition, we also investigate the star formation properties of our sample and the surrounding galaxies in the same environments by probing the global colors such as W3- W1, NUV-r, and g-r. From field to groups/filaments, and to higher density regions, we find a gradual increase in the fraction of red galaxies. These red galaxies are likely to be good examples of passively evolving galaxies, already in the cluster outskirts before falling to the dense cluster core.

Session: ALMA & the related

# Microwave Emission by Spinning Nanoparticles from Circumstellar Disks: Theory and Observational Perspectives with Radio telescopes

*Thiem Hoang (KASI/UST*)

Electric dipole emission from rapidly spinning polycyclic aromatic hydrocarbons (PAHs) is widely believed as an origin of anomalous microwave emission (AME), but recently it encounters a setback due to the non-correlation of AME with PAH abundance seen in a full-sky analysis. AME observations for specific regions with well-constrained PAH features would be crucial to test the spinning dust hypothesis. In this paper, we present physical modeling of microwave emission from spinning PAHs from protoplanetary disks (PPDs) around Herbig Ae/Be stars and T-Tauri stars where PAH features are well observed. Guided by the presence of 10 μm silicate features in some PPDs, we also model microwave emission from spinning nanosilicates. Thermal dust emission for the different grain size distributions is computed using the Monte Carlo radiative transfer code (RADMC-3D). Our numerical results demonstrate that microwave emission from either spinning PAHs or spinning nanosilicates dominates over thermal dust at frequencies $\nu < 60$ GHz, even in the presence of significant grain growth. Finally, we attempt to fit mm-cm observational data with both thermal dust and spinning dust for several disks around Herbig Ae/Be stars that exhibit PAH features and find that spinning dust can successfully reproduce the observed excess microwave emission (EME). Future radio observations with ngVLA, SKA and ALMA Band 1 would be valuable for elucidating the origin of EME and potentially open a new window for probing nanoparticles in circumstellar disks.

Session: ALMA & the related

# SKA

*Bong Won Sohn (KASI),*
*SKA Korea WG*

TBD

Session: ALMA & the related

## Update on the JCMT

*Jongsoo Kim (KASI)*

Since the EAO (East Asian Observatory) took over the operation of the JCMT on March 1, 2015, it has already past more than three years. In my talk, I will update the EAO activities on JCMT Larger Programs, PI (principle investigator) programs, JCMT workshops, POL-2 450 um commission, and JCMT publication statistics.

Session: JCMT I

## The JCMT dust and gas In Nearby Galaxies Legacy Exploration (JINGLE): Current Status

*Ho Seong Hwang (Korea Institute for Advanced Study)*
*and JINGLE team*

JINGLE is a JCMT Large Program designed to systematically study the cold ISM of galaxies in the local Universe. As part of the survey, we observe 193 normal star-forming galaxies at 850 micron with 1/2 of the galaxies also being observed in the CO(J=2-1) line. The survey was extended to the observations of galaxies beyond the main sequence (JINGLE II): (1) starbursting outliers with several times higher star formation rates than the main sequence, and (2) green valley galaxies in the transition region between main sequence and red/dead galaxies. These JINGLE I/II data will provide the largest cohesive sample of gas and dust properties of galaxies in the nearby universe. I will provide an overview of the current status of the JINGLE survey including science highlights from the initial results.

Session: JCMT I

## STUDIES: SCUBA-2 Ultra Deep Imaging EAO Survey and NEP: 850um imaging survey over NEP region

*Hyunjin Shim (Kyungpook National University)*

STUDIES is one of the JCMT Large Program which aim to obtain the deepest 450um image ever (sigma~0.6mJy) with good spatial resolution to overcome Herschel's confusion limit in 350-500um. ~650 hours were assigned to observe two CANDELS fields (COSMOS, SXDS), and the COSMOS part of the program is ~60% completed. Ongoing research topics include deep 450um source counts, evolution of IR luminosity function, morphologies of the submm galaxies, etc. NEP is a newly selected large program in 2017, and is basically an extension of the previously existing multi-wavelength survey over the NEP region (NEP- Wide and Deep) focusing on the AKARI mid-infrared imaging survey. While the strategy is to cover the entire ~4 deg2 over the NEP with SCUBA-2 850um, currently (as of 2018) only <10% of the observation is executed. Studies on the properties of MIR-selected galaxies and submm galaxies is ongoing as a pilot work using the previously released S2CLS images on this field.

Session: JCMT I

## BISTRO 1 and 2

*Woojin Kwon (KASI)*
*on behalf of the BISTRO team*

The large program of JCMT, named B-fields in Star-forming Region Observations (BISTRO-1 and 2), aims to study the roles of magnetic fields in star formation. The status of the project will be reported with some of recent scientific results.

Session: JCMT I

## Nearby Evolved Star Survey (NESS) project with JCMT and beyond

*Hyosun Kim (KASI),*
*Peter Scicluna (ASIAA), on behalf of the NESS team*

I will introduce the Nearby Evolved Star Survey (NESS) project under an international collaborations of EAO countries (Taiwan, Japan, China, Korea) plus UK and Canada. The primary driving science is to understand the mass loss from evolved stars on the asymptotic giant branch (AGB). By achieving the complete volume-limited samples (wedding-cake sampling within 2 kpc) with single dishes such as JCMT and APEX, we aim to derive total gas and dust return to local interstellar medium. The resulting rich data sets enable to study mass-loss history, gas-to-dust ratio, 13CO-to-12CO ratio, dust properties, and physics of mass loss with the help of sufficient angular resolution and sensitivity by extending the surveys to include interferometric observations using ALMA and SMA. The recent advances and future prospects of NESS project will be discussed in this presentation.

Session: JCMT II

## CHIMPS2: Resolving Star Formation in the Galactic Plane

*Kee-Tae Kim (KASI),*
*Toby Moore, Yang Su, Erik Rosolowski, Tetsuhiro Minamidani, Oscar Morata, David Eden, and the CHIMPS2 Team*

The CHIMPS2 survey is to extend the JCMT HARP 13CO/C18O J=3-2 Inner Milky-Way Plane Survey (CHIMPS) and the 12CO J=3-2 survey (COHRS) into the inner Galactic Plane, the Central Molecular Zone (CMZ) and a section of the Outer Plane. When combined with the complementary 12CO/13CO/C18O J=1-0 survey at the Nobeyama 45m (FUGIN) at matching 15" resolution and sensitivity, and other current CO surveys, the results will provide a complete set of transition data with which to calculate accurate column densities, gas temperatures and turbulent Mach numbers. These will be used to: analyze molecular- cloud properties across a range of Galactic environments; map the star-formation efficiency (SFE) and dense-gas mass fraction (DGMF) in molecular gas as a function of position in the Galaxy and its relation to the nature of the turbulence within molecular clouds; determine Galactic structure as traced by molecular gas and star formation; constrain cloud-formation models; study the relationship of filaments to star formation; test current models of the gas kinematics and stability in the Galactic-centre region and the flow of gas from the disc. It will also provide an invaluable legacy data set for JCMT that will not be superseded for several decades. In this talk we will present the current status of the CHIMPS2.

Session: JCMT II

## JCMT Transient Survey: SED modeling of EC 53

*Giseon Baek (Kyung Hee University)*
*and Jeong-Eun Lee*

We present the two-dimensional spectral energy distribution modeling for a variable young stellar object, EC 53. EC 53 is Class I protostar located in the Surpens Main region. A factor of 1.5 mag variability at 850 μm was detected by the JCMT transient survey, which might be caused by the accretion burst on the protostellar disk and envelope. Hinted by EC 53, we aim to investigate the roles of luminosity changes on the sub-mm regime in a bursting young stellar object. We explore the effects of envelope density structure, core size, and cavity opening angle to understand the physical structure of EC 53. Based on the fitting result, we estimate the factor of internal luminosity increment to explain the observed sub-mm variability.

Session: JCMT II

## The "TOP-SCOPE": Follow-up observations of Planck cold clumps with ground- based telescopes

*Tie Liu (KASI),*
*Kee-Tae Kim, and the TOP-SCOPE team*

Stars form in dense regions within molecular clouds, called pre-stellar cores (PSCs), which provide information on the initial conditions in the process of star formation. The low dust temperature (<14 K) of Planck Galactic Cold Clumps (PGCCs) makes them likely to be pre-stellar objects or at the very initial stage of protostellar collapse. "TOP-SCOPE" are joint survey programs targeting at Planck Cold Clumps. "TOP", standing for "TRAO Observations of Planck cold clumps", aims at an unbiased CO/13CO survey of 2000 Planck Galactic Cold Clumps with the Taeduk Radio Astronomy Observatory 14-meter telescope. "SCOPE", standing for "SCUBA-2 Continuum Observations of Pre-protostellar Evolution", is a legacy survey using SCUBA-2 onboard of the James Clerk Maxwell Telescope (JCMT) at East Asia Observatory (EAO) to survey 1000 Planck galactic cold clumps at 850 micron. We are also actively developing follow-up observations with other ground-based telescopes (NRO 45-m, Effelsberg 100-m, IRAM 30-m. SMT, KVN, SMA, ALMA). We aim to statistically study the initial conditions of star formation and cloud evolution in various kinds of environments. I will present the progress and the future plans of this internationally collaborating project.

Session: JCMT II

## Current status of TRAO

*Hyunwoo Kang (KASI)*
*and TRAO tream*

In 2017-2018, The Taeduk Radio astronomy Observatory (TRAO) has supported three Key Science Programs (KSP) and ten General Programs (GP). For installation of new servo system and failure of sub-reflector, there were some unusable times. Even though for the case, TRAO has operated over 92% for scientific observation. It is great that TRAO keep observation time over 97% for the first half of 2018. It is encouraged that TRAO system is being approved by publications. Wide bandwidth of 2 GHz is under construction and hope to be adopted at next season. There should be critical discussion for the wide band support. As a far future plan, Phase Array Feed horn will be announced.

Session: TRAO

## On TRAO Survey Project of Nearby Filamentary Molecular Clouds: FUNS (Filament, the Universal Nursery of Stars)

*Chang Won Lee (KASI)*

How filaments, dense cores, and stars form under different environments is one of the essential questions to address in star formation. To attempt to answer this question we recently started a molecular line survey namely 'Filaments, the Universal Nursery of Stars (FUNS)' toward nearby filamentary clouds in Gould Belt using TRAO 14m single dish telescope equipped with a 16 multi-beam array in high (N2H+ 1-0, HCO+ 1-0, SO 32-21, and NH2D v=1-0) and low (13CO 1-0, C18O 1-0) density tracers. The goals of this survey are to obtain the velocity distribution of low dense filaments and their dense cores for the study of their origin of the formation, to understand whether the dense cores form from any radial accretion or inward motions toward dense cores from their surrounding filaments, and to study the chemical differentiation of the filaments and the dense cores. So far we have almost completed mapping observation with four molecular lines (13CO 1-0, C18O 1-0, N2H+ 1-0, and HCO+ 1-0) on the six regions of molecular clouds (L1251 of Cepheus, Perseus West, Polaris South, BISTRO region of Serpens, California, and Orion B). The cube data for 3CO and C18O lines were obtained for a total of 6 targets over 7.1 deg2. N2H+ and HCO+ data were acquired over 2.2 deg2 of dense regions. All OTF data were regridded to a cell size of 44 by 44 arc-seconds. The 13CO and C18O data show the RMS noise level of about (0.1-0.2) K and N2H+ and HCO+ data show about (0.07-0.2) K at the velocity resolution of 0.06 km/s. Additional observations will be made on some regions that have not reached the noise level for analysis. To identify filaments, we are using and testing programs (DisPerSE, Dendrogram, FIVE) and visual inspection for 3D image of cube data. A basic analysis of the physical and chemical properties of each filament is underway. In the talk we will present all the basic images and the analysis progresses of the data.

Session: TRAO

## FUNS - Filaments, the Universal Nursery of Stars. I. Dynamics and Chemistry of L1478 in the California Molecular Cloud

*Eun Jung Chung (KASI),*
*Chung Won Lee, Shinyoung Kim*

How do filaments and dense cores form in the molecular clouds is one of the essential questions to address in star formation. To figure out this issue, we have recently started a molecular line mapping survey namely 'Filaments, the Universal Nursery of Stars (FUNS)' toward nearby filamentary clouds in the Gould Belt using the TRAO 14m single dish telescope equipped with a 16 multi-beam array. In this presentation, we report the first results on kinematics of a low mass star forming region, L1478 in the California molecular cloud, which contains long filaments with a hub- filament structure. We performed On-The-Fly mapping observations covering ~1.0 square degree area of this region using C18O(1-0) as a low density tracer and about 460 square arcminute area using N2H+(1-0) as a high density tracer. CS(2-1) and SO(32-21) were also used simultaneously to map ~440 square arcminute area of this region. We identified 10 filaments applying the Dendrogram technique to the C18O datacube and 8 dense cores using FellWalker and the N2H+ data set. Basic physical properties of filaments such as mass, length, width, velocity field, and velocity dispersion are derived. It is found that filaments in L1478 are velocity coherent. Especially the filaments which are supercritical and/or marginally supercritical are found to have dense cores detected in N2H+. Non- thermal velocity dispersions derived from C18O and N2H+ suggest that most of the dense cores are subsonic or transonic while the surrounding filaments are transonic or supersonic. We conclude that three filaments in L1478 are gravitationally unstable which might collapse to form dense cores and stars. We also suggest that the core formation mechanisms can be different in individual filaments depending on their morphologies and environments.

Session: TRAO

## The differential chemical distribution of HCN and HCO+ in L1688

*Yunhee Choi (Kyung Hee University),*
*Jeong-Eun Lee (PI), Hyeong-Sik Yun, Yong-Hee Lee, Giseon Baek, Seokho Lee, Minho Choi, Hyunwoo Kang, Keni'chi Tatematsu, Mark H. Meyer, Brandt A. L. Gaches, Neal J. Evans II, Stella S. R. Offner, and Yao-Lun Yang*

As part of the TRAO Science Key Program TIMES (mapping Turbulent properties In star-forming MolEcular clouds down to the Sonic scale, PI: Jeong-Eun Lee), a complete map observed with TRAO will provide a unique database that can be investigate physical and chemical properties of star-forming regions as well as be studied the properties of turbulence in nearby star-forming molecular clouds (Orion A and Ophiuchus molecular clouds). Especially, in L1688 the 13CO line emission peaks around VLA 1623, a Class 0 source with strong molecular bipolar outflows, while the C18O intensity map shows two clumps; one is consistent with the 13CO clump and the other is not clearly recognized in the 13CO map. On the other hand, the HCN J=1–0 and HCO+ J=1–0 emissions are very compact in L1688 compared to the 13CO and C18O maps. However, the distribution of HCN and HCO+ looks different. The HCN line emission is more consistent with PDR excited by the B4 star S1, while the HCO+ line emission follows well along the colliding filament in L1688. This result might imply that stars can form by different mechanisms.

Session: TRAO

## Updates of KVN

*Taehyun Jung (KASI)*

TBD

Session: KVN I

## Understanding high-mass star formation through KaVA observations of water and methanol masers

*Kee-Tae Kim (KASI),*
*Tomoya Hirota, and KaVA Star Formation Science Working Group*

We have been performing a systematic observational study of the 22 GHz water and 44 GHz class I methanol masers in high-mass star-forming regions as a four-year KaVA (KVN and VERA Array) large program since 2016. The primary science goal is to understand the dynamical evolution and circumstellar structures of high-mass young stellar objects (HM-YSOs) by measuring spatial distributions and 3D velocity fields of water and methanol maser features. Our sample consists of 87 HM-YSOs in various evolutionary stages, many of which are associated with multiple maser species. In the first year, we carried out snapshot imaging survey of 23 water and 19 methanol maser sources to check detectability and variability of maser features. In particular, all the 44 GHz methanol masers but one have been first observed with VLBI. Based on these results along with the archive data of VERA and KVN, we elected 16 water and 3 methanol maser sources and started multi-epoch monitoring observations to measure the proper motions of maser features from the second year. By combining follow-up observations with VERA (astrometry), JVN/EAVN (6.7 GHz class II methanol masers), ALMA (thermal molecular lines and continuum), and single-dish spectral line data, we will reveal the physical properties and 3D dynamical structures of disk, jet/outflow, and infalling envelope, and their relationship between the evolutionary phases of HM-YSOs. In this talk, we will present brief summary of our large program and show the initial results.

Session: KVN I

## KVN Key Science Project for Evolved Stars II

*Se-Hyung Cho (KASI),*
*Youngjoo Yun, and KVN Evolved Star WG Members*

We have performed simultaneous time monitoring observations of 22.2 GHz H2O and 43.1/42.8/86.2/129.3 GHz SiO masers toward 16 KVN Key Science Project(KSP) sources of evolved stars at the first stage of the KSP. We aim at investigating spatial structure and dynamical effect from SiO to 22.2 GHz H2O maser regions associated with a mass-loss process and development of asymmetry in circumstellar envelopes. Since 2015A observing season, astrometrically registered maps of both SiO and H2O masers were successfully obtained toward nine KSP sources using the source frequency phase referencing(SFPR) method. Our KSP entered stage two from this year. Here we report the KSP results of evolved stars focused on these successful SFPR sources.

Session: KVN I

## Astrometrically registered maps of H2O and SiO masers toward VX Sagittarii

*Dong-Hwan Yoon (KASI/SNU),*
*Se-Hyung Cho, Youngjoo Yun, Yoon Kyung Choi, Richard Dodson, María Rioja, Jaeheon Kim, Hiroshi Imai, Dongjin Kim, Haneul Yang & Do-Young Byun*

The supergiant VX Sagittarii is a strong emitter of both H2O and SiO masers. However, previous VLBI observations have been performed separately, which makes it difficult to spatially trace the outward transfer of the material consecutively. Here we present the astrometrically registered, simultaneous maps of 22.2 GHz H2O and 43.1/42.8/86.2/129.3 GHz SiO masers toward VX Sagittarii. The H2O masers detected above the dust-forming layers have an asymmetric distribution. The multi-transition SiO masers are nearly circular ring, suggesting spherically symmetric wind within a few stellar radii. These results provide the clear evidence that the asymmetry in the outflow is enhanced after the smaller molecular gas clump transform into the inhomogeneous dust layers. The 129.3 GHz maser arises from the outermost region compared to that of 43.1/42.8/86.2 GHz SiO masers. The ring size of the 129.3 GHz maser is maximized around the optical maximum, suggesting that radiative pumping is dominant.

Session: KVN I

## Development of KVN pipeline

*Youngjoo Yun (KASI),*
*Se-Hyung Cho, Do-Young Byun, Richard Dodson, María J. Rioja*

We present the results of KVN observations, which are automatically processed by the scripts called KVN pipeline. The simultaneous observations at four frequency-bands (K, Q, W and D bands) of KVN have been carried out since 2012, and the rapidly growing data strongly need the automatic process to help the researchers touch their data efficiently. The data reduction process of maser lines is so complicated that it often takes a long time to get a final image cube; generally from several days to several weeks depending on personal experience. The KVN pipeline can yield the final image cube within 2 hours for the 8 hours KVN observation at four frequency-bands with 1 Gbps data recording rate. The results of KVN pipeline show a good agreement with the manually reduced ones, and the consistency of data reduction can be kept for dealing with the long term monitoring observations. The pipeline-processed results of the late-type stars show the precisely-determined relative spatial distributions between the H2O and SiO masers emitted from the circumstellar envelopes (CSEs) and give us the important physical information to study the stellar evolution of the late-type stars.

Session: KVN I

# iMOGABA

*Sang-Sung Lee (KASI)*

TBD

Session : KVN II

## First results from PAGaN

*Sascha Trippe (Seoul National University),*
*Jongho Park, Minchul Kam*

The Plasma-physics of Active Galactic Nuclei (PAGaN) project is a Key Science Program which started at the KVN in late 2016. I present two recent results.

Firstly, we investigated the linear polarization and Faraday rotation in the radio cores of 8 blazars. We find a systematic increase of RMs at higher observing frequencies in our targets. The RM–v relations follow power laws with indices distributed around 2, indicating conically expanding outflows serving as Faraday rotating media.

Secondly, we studied the linear polarization in 3C84 with KVN data obtained from 86 to 142 GHz. We found, for the first time, two polarized regions in the jet, with Faraday rotations measures of a few hundred thousand rad/sqm.

Session : KVN II

## Probing the Faraday screen in the nuclear region of 3C 84

*Minchul Kam (Seoul National University),*
*Sascha Trippe*

We present the result of the multi-frequency polarimetric observations to explore the environment of 3C 84 in the center of giant elliptical galaxy NGC 1275. We used the Korea VLBI Network (KVN) at 22, 43, 86, and 129 GHz as part of our Plasma-physics of Active Galactic Nuclei (PAGaN) project and Very Long Baseline Array (VLBA) archival data at 43 GHz. At the VLBI core, the linear polarization is extremely weak whereas it is relatively strong at a hotspot in the jet. By using the 256 MHz bandwidth of VLBA at 43 GHz, we detected the rotation measure (RM) at the core. Surprisingly, both positive and negative RM are detected and the absolute values are lower than the expectation. This is inconsistent with previous results from the Submillimter Array (SMA) and the Combined Array for Research in Millimeter wavelength Astronomy (CARMA) observation at 220 and 340 GHz whose RM were always positive. To explain this, we suggest two possible scenarios. One is that EVPA rotations are saturated because the Faraday screen is internal to the jet. The other one is that the Faraday screen is hot accretion flow. To probe the origin of the Faraday rotation at the core, we proposed KVN observation at 86, 90, 94, 129, 138, and 144 GHz.

Session: KVN II

## Core-Jet Blending Effects in AGN Under the KVN View

*Juan-Carlos Algaba (Seoul National University),*
*Jeffrey Hodgson, Sin-Cheol Kang, Dae-Won Kim, Jae-Young Kim, Jee Won Lee,*
*Sang-Sung Lee, Sascha Trippe*

A long standing problem in the study of Active Galactic Nuclei (AGNs) is that the observed VLBI core is in fact a blending of the actual AGN core (classically defined by the $\tau = 1$ surface) and the upstream regions of the jet or optically thin emitting region flows. This blending may cause some biases towards the observables of the core, such as its flux density, size or brightness temperature, which may lead to misleading interpretation of the derived quantities and physics. We study the effects of such blending under the view of the Korean VLBI Network (KVN) for a sample of AGNs at 43~GHz by comparing their observed properties with observations with the Very Large Baseline Array (VLBA). Our results suggest that the observed core sizes are a factor ~11 larger than these of VLBA, which is different than the factor ~18 expected by purely considering the different resolution of the two facilities. We investigate possible dependencies with source compactness, viewing angle or redshift, finding no signs of correlations. We suggest the use of a common factor, albeit a large scatter may be used, to consider blending effects in KVN measurements.

Session: KVN II

## Status of Sejong Space Geodetic Observation Center

*Sang-Oh Yi (National Geographic Information Institute)*

TBD

Session: Prospects

# Do you know about the Radio frequency regulation of the Radio Astronomy Service?

*HyunSoo Chung (KASI)*

It is important to protect bands allocated to the science services from emissions spilling over from adjacent bands in order to ensure the efficacy of scientific research. Of the several scientific services, the passive-use allocations to the Radio Astronomy Service (RAS) and the Earth-exploration Satellite Service (EESS) are particularly vulnerable to interference because noise levels must be extremely low in order to detect the faint signals generated by natural phenomena and processes.

However, in practice, most spectral allocations in the ITU Radio Regulations are shared with active services and, with the introduction of higher-powered space transmitters and the use of spread spectrum modulation techniques, both EESS and RAS are increasingly vulnerable to interference, even in their protected bands. Thus, while spectral sharing of the passive service allocations with compatible active service allocations are possible in some circumstances, special care must be taken to provide protection for scientifically critical spectral windows and for geographic regions where radio telescopes are located. Preserving interference free access to the radio spectrum for scientific use is thus crucial both to provide information on the conditions of our planet Earth that have global consequences and to enable discoveries that will lead to a better understanding of the natural world.

Radio regulations are formulated at several levels and involve a plethora of acronyms. At the international level, regulations for use of the radio spectrum that will become treaty obligations of members of the International Telecommunication Union (ITU) are formulated at WRCs (World Radiocommunication Conferences). The ITU Radiocommunications Sector (ITU-R) prepares material for these conferences and drafts recommendations that may be incorporated into regulations or, at the very least, are influential documents for telecommunications regulators and spectrum users around the world.

Much of the work of the ITU-R takes place through its Study Groups, which are further organized into working parties and task groups. These deal with specific areas or problems and provide studies of questions concerning technical and procedural aspects of radio communications. Study Group 7 has responsibility for use of the spectrum for scientific research (the science services): remote sensing systems are the concern of Working Party 7C (WP7C), and radio astronomy is the concern of Working Party 7D (WP7D). The other services under Study Group 7 are WP7A, time and frequency standards, and WP7B, space research and EESS (mostly communications).

Session: Prospects

## Antarctic Activity Plan of KASI

*Young Chol Mihn (KASI)*

TBD

Session: Prospects

## Pre-study for Extended KVN

*Do-Young Byun (KASI),*
*D.-Y. Byun, T.-H. Jung, S.-S. Lee, S.-O. Wi, S.-H. Cho, Y.-C. Mihn, S.-T. Han , H.-G. Kim and EKVN Science Working Group*

KVN is a millimeter VLBI system composed of three 21m-diameter radio telescopes in Korea. Although KVN has unique capability observing four-frequency band simultaneously, its imaging capability is highly limited because of the number of baselines. To enhance its imaging capability, there has been continuous request from VLBI community in Korea to extend the KVN in its number of telescopes from 3 to 5 or more. In 2017, we conducted pre-study of EKVN. This talk introduces results of the pre-study and prospect of EKVN.

Session: Prospects

## The 50m-class submillimeter single dish telescope LST

*Ryohei Kawabe (NAOJ)*

We report on a plan to constract a 50m class millimeter and submillimeter single dish telescope, the Large Submillimeter Telescope (LST). The telescope is optimized for wide-area imaging and spectroscopic surveys in the 70 to 420 GHz frequency range, which just covers main atmospheric windows at millimeter and submillimeter wavelengths for good observing sites such as the ALMA site in Chile. We also target observations at higher frequencies of up to 1 THz, using an inner part high-precision surface. Active surface control is required in order to correct gravitational and thermal deformations of the surface. One of major technical challenges is correction for the wind-load deformation, which requires measurements and feedbacks in much shorter time scale. We will report the recent progress on the technical developments of the LST and international collaboration.

Session: Prospects

## Science Cases of LST and AtLAST

*Kotaro Kohno (University of Tokyo)*

I will report some key science cases for a survey-oriented large submm single dish telescope, which must be complementary to ALMA.

Session: Prospects

## Star Formation and Interstellar Gas in Vertically Resolved Edge-on Galaxies

*Kijeong Yim (KASI),*
*Tony Wong (University of Illinois at Urbana-Champaign), Rich Rand (University of New Mexico)*

We investigate radial variations of the scale heights and the vertical velocity dispersions of a sample of edge-on galaxies (NGC 891, 4013, 4157, 4565, and 5907) using OVRO/BIMA/CARMA 12CO, VLA/JVLA HI, and Spitzer 3.6 micron data. We show that the disk thicknesses increase with radius and the velocity dispersions decrease with radius, which are contrary to the assumed constant values used in many literatures. The measured disk thicknesses are used to estimate the gas volume density, one that is directly related to star formation rate. Using the volume densities and the vertical velocity dispersions, we derive the turbulent interstellar gas pressure and show a strong correlation between the gas pressure and the star formation rate.

Session: Poster

## Technical notes on the KVN single-dish observation

*Panomporn Poojon (Yonsei University),*
*Aeree Chung, Bumhyun Lee, Junhyun Baek, Taehyun Jung, Bong Won Sohn,*
*Se-Heon Oh, Chandreyee Sengupta, and the MALATANG team*

We are currently carrying out KVN single-dish observations of nearby IR-bright galaxies selected from the MALATANG JCMT legacy survey. An immediate goal is to study the spectral energy distribution of the sample at the KVN observing frequency range, which can potentially provide diagnostics for the power source of active galaxies at various redshifts. As a byproduct, we obtained the antenna gain measurements using plants and quasars. In this work, we report our gain factors and comparisons with the previous measurements. In addition, we discuss the performance of the cross scan mode in RA/DEC direction, which was adopted for our observations due to large extents in the sky of the sample.

Session: Poster

## The impact of the ram pressure on the multi-phase ISM probed by the TIGRESS simulation

*Woorak Choi (Yonsei University),*
*Chang-Goo Kim, Aeree Chung*

Galaxies in the cluster environment interact with the intracluster medium (ICM), losing the interstellar medium (ISM) and alternating their evolution. Observational evidences of the extraplanar ISM stripped by the ICM's ram pressure are prevalent in HI imaging studies of cluster galaxies. However, current theoretical understanding of the ram pressure stripping (or ICM-ISM interaction in general) is still limited mainly due to the lack of numerical resolution at ISM scales in large-scale simulations. Especially, self-consistent modeling of the turbulent, multiphase ISM is critical to understand star formation in galaxies interacting with the ICM. To achieve this goal, we utilize the TIGRESS simulation suite, simulating a local patch of galactic disks with high resolution to resolve key physical processes in the ISM, including cooling/heating, self-gravity, MHD, star formation, and supernova feedback. We then expose the ISM disk to ICM flows and investigate the evolution of star formation rate and the properties of the ISM.

Session: Poster

## Simultaneous dual-frequency observations of AGNs with KaVA

*Guang-Yao Zhao (KASI),*
*T. Jung, and KaVA/EAVN AGN working group*

The KVN-style simultaneous multi-frequency receiving mode has been demonstrated to be promising for mm-VLBI observations. Recently, more VLBI facilities all over the globe have started to implement compatible optics systems. Simultaneous dual/multi-frequency VLBI observations at mm wavelengths with international baselines are thus possible. We will present the results from the first successful simultaneous 22/43 GHz dual-frequency observation with KaVA, including images and astrometric results. Our analysis shows that the newly implemented simultaneous receiving system has brought a significant extension of the coherence time of the 43 GHz visibility phases along the international baselines. The astrometric results obtained with KaVA are consistent with those obtained with the independent analysis of the KVN data. Our results thus confirm the good performance of the simultaneous receiving systems for VERA stations. Future simultaneous observations with more global stations will bring even higher sensitivity and micro-arcsecond level astrometric measurements of the targets.

Session: Poster

## Efficiency estimation of ASTE receiver optics using measured beam patterns from KASI band 7+8 feed horn

*Bangwon Lee (KASI),*
*Jung-won Lee, Hyunwoo Kang, Do-Heung Jexa*

We conducted efficiency calculation in a prototype receiver optics for ASTE 10 meter telescope using the measured beam patterns of the band7+8 feed horn.

Beam measurements results are summarized and estimated aperture efficiencies over band7+8 frequency range are presented.

Session: Poster

## N-PDFs of Individual Clumps in Star-Forming Molecular Clouds

*Yong-Hee Lee (Kyung hee Univ.),*
*Jeong-Eun Lee, Steve Mairs, Doug Johnstone, Jongsoo Kim*

The probability distribution function of column density (N-PDF) has been used for studying the characteristics of molecular clouds. In particular, the properties of N-PDF can reveal the nature of turbulence and gravity inside the molecular cloud. We use the 450 μm and 850 μm dust continuum data observed via the JCMT Transient Survey (Johnstone et al. 2018), which has observed IC348, NGC1333, NGC2024, NGC2071, OMC 2/3, Ophiuchus cores, Serpens Main, and Serpens South molecular clouds in more than 20 epochs. We produced high-sensitivity maps by co-adding the multi-epoch data to derive the dust temperature and column density maps of those clouds. We here present the N-PDFs of eight molecular clouds as well as individual clumps in each cloud.

Session: Poster

## Two-year monitoring of a variable protostar, EC 53, in the Transient Survey

*Hyunju Yoo (Chungnam National University),*
*Jeong-Eun Lee, Steve Mairs, Doug Johnstone, and Gregory J. Herczeg*

Gravitational collapse is the fundamental and important process in star formation. Since the accretion rate during the protostellar phase is believed to be variable, observing the temporal change of protostellar luminosity is challenging for studying mass assembly of young stellar object. The variability of Class I protostar (EC 53) at 850 um, which is consistent with the periodically varying K-band magnitude has been recently reported from JCMT-Transient survey. In this work, we present the one-and-half period of the light curve of EC 53 at both 450 um and 850 um from two-year monitoring using JCMT/SCUBA-2. Although there is a lack of observing point at the low brightness phase, the sub-mm fluxes at both 450 um and 850 um show dimming and brightening, which is consistent with K-band light curve. The flux enhancement at 450 um is 1.3 times higher than that at 850 um. We discuss about the distribution and change of dust temperature at both quiescent and burst phases of EC 53.

Session: Poster

## TRAO Key Science Program: mapping Turbulent properties In star-forming MolEcular clouds down to the Sonic scale (TIMES)

*Hyeong-Sik Yun (Kyung Hee University),*
*Jeong-Eun Lee, Yunhee Choi, Neal J. Evans II, Stella S. R. Offner, Yong-Hee Lee, Giseon Baek, Minho Choi, Hyunwoo Kang, Seokho Lee, Ken'ichi Tatematsu, Mark H. Heyer, Brandt A. L. Gaches, Yao-Lun Yang*

Turbulence is a phenomenon which largely determines the density and velocity fields in molecular clouds. Turbulence can produce density fluctuation which triggers a gravitational collapse, and it can also produce a non-thermal pressure against gravity. Therefore, turbulence controls the mode and tempo of star formation. However, despite many years of study, the properties of turbulence remain poorly understood. As part of the Taeduk Radio Astronomy Observatory (TRAO) Key Science Program (KSP), "mapping Turbulent properties In star-forming MolEcular clouds down to the Sonic scale (TIMES; PI: Jeong-Eun Lee)", we have mapped two star-forming clouds, the Orion A and the Ophiuchus molecular clouds, in 3 sets of lines (13CO 1-0/C18O 1-0, HCN 1-0/HCO+ 1-0, and CS 2-1/N2H+ 1-0) using the TRAO 14-m telescope. We aim to map entire clouds with a high-velocity resolution (~0.05 km/s) to compare turbulent properties between two different star-forming environments. We present the results using a statistical method, Principal Component Analysis (PCA), that is a useful tool to represent turbulent power spectrum.

Session: Poster