ngvla
Next Generation Very Large Array

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Oral Presentations

ngVLA Key Science Goals

David Wilner

Center for Astrophysics | Harvard & Smithsonian

I will briefly review the five Key Science Goals that were developed through a community driven process to determine the scientific priorities that drive the ngVLA technical requirements. These Key Science Goals, originally developed in 2017 (ngVLA memo #19) and revisited in 2024 (ngVLA memo #125), target fundamental astrophysical questions requiring observations at centimeter and millimeter wavelengths that cannot be achieved by any other facility: (1) unveiling the formation of Solar System analogues, (2) probing planetary initial conditions and life via astrochemistry, (3) charting galaxy evolution across cosmic time, (4) testing fundamental physics with pulsars, and (5) exploring black hole formation in the multi-messenger era. These Key Science Goals will continue to be revisited to ensure they endure as outstanding problems of high priority.

ngVLA antenna site selection in Mexico: Status and strategic priorities

Alfonso Trejo-Cruz

IRyA-UNAM

The Next Generation Very Large Array (ngVLA) will be the largest radio interferometer ever built in the northern hemisphere. With 263 antennas distributed across the US, Canada, and Mexico, the ngVLA will open a new window on the universe through ultra-sensitive imaging of spectral lines and continuum emission with milliarcsecond resolution.

ngVLA's MID Array, projected to have six antennas in Northern Mexico, will provide some of its longest baselines. This translates into high angular resolution observations, critical for the ngVLA key science goals.

We will discuss ongoing tasks for the MID site selection in the Chihuahua and Sonora states in Northern Mexico, from astronomical and atmospheric aspects to jurisdiction, geological, topography, infrastructure, and social considerations. We also discuss the experiences, successes, challenges, and lessons learned from members of civil society, universities, and public officials over the past several years.

Connected to site selection tasks, we will summarize the state and timeline of instrumentation being built for site monitoring in Mexico, as well as their potential for community engagement for deploying, operating, and analysing upcoming data products.

We will finalize with a discussion of the actions that the Mexican community is already planning for the next few years and that will take the antenna site selection to the next stage.

Tracing the route to the next generation Very Large Array Project in Mexico

Luis Zapata

IRyA-UNAM

Mexico has emerged as a key international partner in the development of the next-generation Very Large Array (ngVLA), a transformative radio astronomy project led by the U.S. National Science Foundation's National Radio Astronomy Observatory (NRAO). The participation of Mexican institutions, particularly the National Autonomous University of Mexico (UNAM), has evolved from scientific collaboration to a strategic role in the design, optimization, and future deployment of the array across North America. In this talk, I will review the efforts of the Mexican astronomical community toward the ngVLA, highlighting contributions to array configuration optimization, calibration strategies, and the characterization of candidate antenna sites in Mexico. These activities are helping maximize the scientific performance of the observatory while establishing Mexico as a key partner in one of the most ambitious radio astronomy facilities of the coming decades.

The Wetterstein Millimeter Telescope: Current Project Status and Prospects for transatlantic VLBI with the ngVLA

Jompoj Wongphechauxsorn

JMU Würzburg

The Wetterstein Millimeter Telescope (WMT) is a planned radio telescope to be located at the Environmental Research Station Schneefernerhaus on the Zugspitze in Bavaria's Wetterstein Mountains. Its design is based on the ngVLA antenna. The WMT is planned to operate at radio frequencies between 1.2 and 120 GHz, with the goal of eventually extending its capabilities toward shorter millimeter wavelengths, such as 230 GHz. It is envisioned as an interdisciplinary research platform for astronomy, geoscience and environmental research, satellite technology, space situational awareness, solar system studies, and data and technology development. We will present the current project status including a description of ongoing site-characterization work and system design. In particular, we will describe how the WMT will serve as a very-long-baseline station for the ngVLA.ts location in Central Europe and its planned broad frequency coverage make it an interesting candidate for both cm- and mm-VLBI applications, including studies of compact active galactic nuclei, astrometry, geodetic VLBI, and technical developments for future multi-frequency observing systems.We will also discuss ongoing site-characterization work, including radio-frequency interference surveys and assessments of the environmental conditions at the Zugspitze site. These studies are essential for evaluating the feasibility of sensitive radio and millimeter-wave observations, defining realistic observing strategies, and identifying the most promising frequency ranges for future WMT operations.

Overall, the WMT aims to provide a flexible alpine platform that connects local interdisciplinary research with the scientific and technical goals of international VLBI networks and the ngVLA.

Update on the long baselines of the ngVLA

Lucas Hunt

NRAO

The next-generation Very Large Array (ngVLA) is currently being designed by the National Radio Astronomy Observatory (NRAO) to address the high priority goals of modern astrophysics at radio frequencies from 1.2-116 GHz. It will replace both the Very Large Array (VLA) and the Very Long Baseline Array (VLBA). The current design for the long baselines (ngVLA-LONG) has multiple 18-meter antennas located at both current VLBA sites and new locations across North America, with the option to include antennas from different parts of the telescope to improve sensitivity and UV-coverage as part of a tailored science subarray. ngVLA-LONG will become the premier VLBI instrument, allowing high resolution astronomy, astrometry, and near-Earth science. This talk will provide an update to the ngVLA project and cover the technical aspects and science use cases of ngVLA-LONG.

Anchoring the Sky: Astrometry and the CRF in the Era of the ngVLA

Phil Cigan

U.S. Naval Observatory

The International Celestial Reference Frame (ICRF), realized through VLBI observations of compact extragalactic radio sources, underpins modern positional astronomy — anchoring source positions, spacecraft navigation, and the alignment of catalogs across the spectrum, including the Gaia optical frame. Yet the frame is not static: its defining AGN exhibit structure, flux variability, and astrometric jitter at the tens-of-microarcsecond level, effects that limit frame accuracy while also encoding rich astrophysics. In this talk for the broader imaging community, I will overview the U.S. Naval Observatory's work in astrometry and the celestial reference frame, review the VLBA's central role in reference-source astrometry, imaging, and monitoring, and discuss how the ngVLA — particularly its long-baseline elements, and sister arrays — can play a role in this work. Key topics include positional jitter in ICRF sources, blazars as improved reference-source candidates, synergies with Gaia DR4, USNO's publicly available data products, and future high-resolution networks and co-observing opportunities.

Neural-Network Based Image Reconstruction of ngVLA data

Andrea Isella

Rice University

Radio-interferometric images are constructed via sparse visibility sampling, and classical CLEAN-based image reconstruction algorithms struggle with spatial filtering, complex morphologies, and uncertainty quantification. Alternative approaches that directly model the measured complex visibilities overcome some of these limitations but suffer from poor convergence and generally require user-guided optimization of image priors and model hyperparameters.

In my talk, I will present a self-supervised neural network workflow called SIFARI (Self-Supervised Interferometric Fitting for Astronomical Radio Imaging) that fits measured complex visibilities with minimal hyperparameters and requires no image training set or prior.

This method, which uses Fourier features, yields an effective point-source response nearly an order of magnitude narrower than the natural-weighting CLEAN beam, retains much more flux than CLEAN in the presence of spatial filtering, and systematically improves image fidelity across a wide range of morphological features. Additionally, we use Stochastic Weight Averaging-Gaussian (SWAG) to sample plausible network weights and produce uncertainty and signal-to-noise diagnostics. This is a major improvement over CLEAN images, which allow noise to be measured only in emission-free regions.

Applied to existing ALMA observations, the neural reconstruction simultaneously recovers both extended and compact emission, eliminating the need for weighting functions and thereby maximizing the observations' sensitivity. For ALMA long-baseline-only, neural-network image reconstruction enables self-calibration, whereas CLEAN fails, resulting in lower noise in the reconstructed image.

In my talk, I will present SIFARI image reconstruction of synthetic ngVLA data and compare them with standard CLEAN images.

Scaling Down the ngVLA Computational Footprint: Novel Algorithms and Parallel Implementations

Rob Selina

NRAO

Current estimates indicate that the Size of Computing (SofC) requirements for Next-Generation Very Large Array (ngVLA) imaging utilize between 30 and 60 PetaFLOPs when applying existing algorithms. This computational demand equals the processing power of the world's largest supercomputers, potentially rendering dedicated ngVLA imaging operationally impractical and financially unviable. The primary drivers of these high SofC requirements are the iterative algorithms necessary to achieve full scientific sensitivity. To process ngVLA data efficiently without compromising scientific output, ongoing research and development addresses two critical areas: the design of novel algorithms to minimize raw computational overhead, and the implementation of advanced software architectures that leverage modern, massively parallel hardware and large-scale parallel computing platforms. This presentation outlines recent advancements in both domains. Specifically, we evaluate new algorithms that significantly accelerate the convergence rate of iterative imaging while optimizing runtime scaling across large-scale parallel computing platforms. Collectively, these developments demonstrate strong potential to reduce the ngVLA computational footprint to a technologically feasible and cost-effective scale.

Dust Continuum from Protostellar to Planet-Forming Disks in the ngVLA Era

Takahiro Ueda

NAOJ

Millimeter observations with ALMA have transformed our view of protoplanetary disks, revealing compact disks around protostars and diverse substructures in protoplanetary disks. Yet the regions most directly connected to planet formation often remain optically thick at ALMA wavelengths. This is particularly true for the inner regions and bright rings of Class II disks, as well as much of the continuum emission from Class 0/I disks, leaving the physical conditions and evolution of solids in these regions poorly constrained. With its combination of longer observing wavelengths and high angular resolution, the ngVLA will probe deeper toward disk midplanes and resolve structures on the spatial scales where planets form. In this talk, I will review recent progress in (sub)millimeter dust continuum observations across disk evolution, from embedded protostellar disks to planet-forming disks, emphasizing what current data can and cannot determine. I will then discuss how the ngVLA, in concert with ALMA, can trace the distribution and evolution of planet-forming solids from au scales to the outer disk. These observations will provide more robust inventories of the material available for planet formation and new tests of planet formation theories.

Automated Regularized Maximum-Likelihood Imaging of Protoplanetary Disks in the ngVLA Era

Jesús Miguel Jáquez Domínguez

IRyA-UNAM

High-fidelity, high-resolution, and high-sensitivity images are essential for characterizing substructures linked to planet formation in protoplanetary disks. Radio interferometry provides the required angular resolution, but it samples complex visibilities rather than images. These visibilities encode the sky brightness distribution in Fourier space. Because the sampling is incomplete, reconstruction is an ill-posed inverse problem, and dirty images contain artifacts set by the synthesized beam. CLEAN remains the standard method for mitigating these artifacts. However, it can be computationally expensive, depends strongly on user-defined parameters, and may have limited fidelity when recovering extended emission or fine substructures, especially at high angular resolution. These limitations will become increasingly important for the ngVLA, whose multi-scale configurations will produce complex beams. Regularized maximum-likelihood imaging offers a complementary approach by fitting visibility data directly while imposing motivated image-domain regularization. We present a user-friendly, automated pipeline based on MPoL, a PyTorch framework that uses differentiable optimization and GPU acceleration to reconstruct interferometric images. The pipeline automates hyperparameter exploration, cross-validation, and image reconstruction. We apply this framework to disks in Taurus and in the DSHARP sample, comparing morphology, fidelity, and computational performance with CLEAN products. Finally, using synthetic ngVLA observations, we show that regularized visibility-domain imaging will be crucial for exploiting the resolution and sensitivity of future interferometers.

A new framework for the visibility analysis of dust disks and its application to data from ALMA and ngVLA

Munetake Momose

NAOJ

Recently, we propose a new framework of visibility analysis for deriving the radially-averaged surface brightness profile and geometry for a geometrically thin axisymmetric disk from the continuum emission (Aizawa, Muto, & Momose, 2024; 2026). This framework, named "protomidpy", estimates automatically the geometric parameters (i.e., the disk's inclination angle, the central position in the sky-plane, and the position angle of the major axis) and optimum hyper-parameters in the Gaussian regression inference from visibility data, enabling to derive the averaged radial brightness distribution of the disk as well as the deviation from it more accurately than previous frameworks. We present the framework and its application to real ALMA data, particularly from the DSHARP project. Thanks to the more accurate analysis enabled by protomidpy, we have newly identified an one-arm spiral in the disk surrounding Elias 27 and found a trend that millimeter dust emission within 5 au in radius is decreasing on a timescale of 3 Myr. Based on the above, we will also discuss what new scientific opportunities will emerge once the ngVLA enables high-resolution observations in the wavelength bands where the innermost regions of the disks are transparent.

Characterizing Protoplanetary Disk Solids with Well-Sampled Centimeter-Band Spectra

Anna Fehr

Center for Astrophysics | Harvard & Smithsonian

Measuring the masses and other properties (e.g., size distributions) of the populations of solids in protoplanetary disks requires observations of their thermal continuum radiation at long (~centimeter) wavelengths. where that emission is reliably optically thin. However, at present such observations are limited and expensive, forcing most disk measurements to rely on millimeter data where pollution from high optical depths is problematic. I will present some initial results from our ongoing VLA Large Program to measure well-sampled centimeter-to-submillimeter continuum spectra for a large sample of disks (~80), along with a novel method to combine such observations with high-resolution images. The new observations yield more reliable estimates of dust masses across the sample by leveraging improved constraints on their opacity spectrum shapes. We will use those results to assess how high optical depths bias the population-level trends inferred from millimeter surveys. Combining the spectra with high-resolution imaging further enables robust measurements of how density, temperature, and grain properties vary radially in individual disks, even when high-resolution data are unavailable at long wavelengths. Together, these results demonstrate the potential of sensitive centimeter continuum observations to deliver transformative scientific returns while highlighting the need for the higher spatial resolution at long wavelengths that only the ngVLA can provide.

Tracing planetesimal belts with the ngVLA: the new potential of tracing gas in young debris disks

Brenda Matthews

National Research Council of Canada

Debris disks are collisionally-evolving disks which are comprised of planetesimal belts and the dust and gas produced by their internal collisions. ALMA has detected CO and CI gas associated with many young debris disks around A type stars. The origin of the gas has been debated between leftover material from a protoplanetary disk, but in some cases, it is more likely that the gas is of secondary origin. This adds one more aspect to help understand the transition between younger protoplanetary disks.

ALMA has also revealed a dichotomy in the protoplanetary disk population, with 20% of disks exhibiting significant ringed substructures to large radii and the remaining 80% of disks being relatively faint and compact. The substructure present suggests that planet formation may be well underway by the Class II phase, prompting exploration of the younger disk stages. This dichotomy has been noted to have a parallel expression in debris disks, the collisionally-generated second generation disks around main sequence stars, detected around ~ 20% of main sequence stars. Connecting the dots between the protoplanetary and debris disk phases goes through the Class III disk phase, and the role of dust evolution, trapping and transport needs to be understood to understand this transition. Some studies have suggested that the ringed bright Class II disks are the precursors to the observed debris disk population, and so these objects should retain their substructure to later phases.

The ngVLA will have several advantages over ALMA in the study of this transitional population, including sensitivity to gas associated with these disks, and the ability to take complete censes of most nearby star-forming regions. In addition, the fact that gas detections can now be pursued in debris disks may provide new ways to identify the key underlying structures we cannot see directly, the planetesimal belts.

Understanding what the connection between the transition phase and planetesimal belts has to do with the diversity of planetary system outcomes is a key question that can be addressed by the ngVLA.

Predictions of dust continuum observations of circumplanetary disks with ngVLA: A case study of PDS 70 c

Yuhito Shibaike

Kagoshima University

During their gas accretion phase, gas giant planets form small gaseous disks around themselves, known as circumplanetary disks (CPDs). These disks contain dust particles similar to those found in protoplanetary disks, and the particles may serve as the building blocks of large moons. The young T Tauri star PDS 70 hosts two gas-accreting planets. Continuum emission associated with one of them, PDS 70 c, has been detected by ALMA at multiple wavelengths and is interpreted as thermal emission from dust in its CPD. The multiwavelength ALMA observations suggest that the CPD contains an optically thick dust ring. We reproduce the observed multiwavelength ALMA emission and predict how the dust emission would appear in ngVLA observations by extending the wavelength coverage from submillimeter to centimeter wavelengths. We find that the dust thermal emission should be detectable with the ngVLA in Bands 6 (3 mm), 5 (7 mm), and 4 (11 mm). We also find that the size and width of the dust ring in the CPD could be confirmed with ngVLA Band 6 observations within a reasonable observing time.

The Free-free Emission View of Disk Photoevaporation with the VLA and, eventually, the ngVLA

Ryan Boyden

NRAO

I will present new VLA observations that detect 15 externally ionized proplyd disks in the Orion NGC 2024 cluster. NGC 2024 is the youngest star-forming cluster (~0.2-0.5 Myr) in the solar neighborhood (d < 2 kpc), providing a critical window to study planet formation at the earliest stages of star cluster formation. We have imaged NGC 2024 at 3, 6.4, and 22 GHz with the VLA to search for free-free-emitting photoevaporating disks (i.e., "proplyds") in the region. We detect 15 proplyds, more than tripling the number of known photoevaporating disks in the region. The detected proplyds all emit strong optically thin free-free emission with a cusp-like morphology at centimeter wavelengths, indicating the emission is produced by gas that is photoevaporated off the disk and ionized by UV radiation from massive stars. We measure the mass-loss rate of each detected proplyd and find values that are one to two orders of magnitude lower than the ones measured towards proplyds in the more-evolved Orion Nebula Cluster (>1 Myr). This suggests that while young (<1 Myr) disks are influenced by the cluster environment, the peak of external photoevaporation is delayed to later stages (>1 Myr) of disk evolution. Our VLA observations set the stage for future, transformative studies of photoevaporating disks with ngVLA. I will explain how ngVLA will enable us to, for the first time, spatially resolve photoevaporating disks in the dozens of additional clusters that are more distant than Orion but key to pinpointing the environmental influence on planet formation.

Revealing Disk Properties in the Low-Metallicity Environment with ngVLA

Natsuko Izumi

Nagoya University

Understanding planet formation is one of the fundamental problems in astrophysics. Previous studies have shown the well-known planet–metallicity correlation: the fraction of stars hosting giant planets decreases with metallicity. Since low-metallicity environments resemble those of damped Lyα systems and the early stages of Galactic disk formation, understanding the origin of this correlation is essential for revealing how planets formed in the early Milky Way. Two key properties may determine the probability of planet formation: protoplanetary disk lifetime and disk mass, since disks provide the material from which planets form. Previous near-infrared observations of star-forming regions in the low-metallicity outer Galaxy suggested shorter disk lifetimes than in the solar neighborhood, providing a possible explanation for the planet–metallicity correlation. However, our recent JWST observations with mid-infrared, which is a better tracers of disks than near-infrared, suggest that disk lifetimes in the outer Galaxy may be comparable to those in the solar neighborhood. This result suggests that disk mass, rather than disk lifetime, may be the primary factor controlling planet formation in low-metallicity environments. However, disk masses have never been measured in such environments because these observations require exceptional sensitivity and angular resolution, even for the relatively nearby outer Galaxy. Therefore, we propose that the combination of the ngVLA and the outer Galaxy provides the best opportunity to investigate properties of disks, such as disk mass, in low-metallicity environments. In this conference, I will present our latest JWST results and discuss future studies with the ngVLA.

ngVLA polarization in star-forming regions and protoplanetary disks

Zhe-Yu Daniel Lin

NRAO

Polarization is a unique tool that captures physics unseen with total intensity alone and has been used throughout the process of star formation from dense cores to outflows to protoplanetary disks. With improved sensitivity and angular resolution, the ngVLA is poised to make significant advancements. In the past decade, ALMA has been the leading facility in detecting and resolving polarization in the (sub)millimeter wavelengths, which has opened windows to new physics, like dust scattering, new modes of grain alignment, and enabled statistical studies of dust polarization. In this talk, I will summarize recent work in the study of polarization and discuss how sensitive, centimeter-wavelength polarization with the ngVLA could unveil the origin of aligned dust grains in protoplanetary disks and trace the magnetic fields through Zeeman and Goldreich-Kylafis effects.

Probing Magnetic Fields in Circumstellar Disks: From ALMA to the ngVLA

Satoshi Ohashi

The University of Tokyo

Magnetic fields are expected to play a key role in regulating accretion and angular momentum transport in circumstellar disks during star and planet formation. However, direct observations of disk magnetic fields remain challenging because of the limited angular resolution and sensitivity of current facilities. Furthermore, the interpretation of dust polarization is often ambiguous, since polarization can arise not only from magnetically aligned grains but also from other grain-alignment mechanisms and dust self-scattering, particularly as dust grains grow.

In this presentation, I will present recent ALMA observations of several circumstellar disks in which the polarization morphology and its wavelength dependence suggest that the dust grains may be aligned with magnetic fields. I will discuss the observational evidence for magnetic alignment, the remaining uncertainties in distinguishing it from alternative polarization mechanisms, and the implications for disk magnetic-field structures. Finally, I will discuss future prospects for resolving these ambiguities and directly constraining magnetic fields in planet-forming disks with the high angular resolution and sensitivity of the ngVLA.

Magnetic dipole emission from protoplanetary disks: Probing solid-phase iron with the ngVLA

Ryo Tazaki

The University of Tokyo

Iron is a major constituent of dust grains in protoplanetary disks; however, the chemical form of solid-phase iron has not yet been identified observationally. Determining the nature of solid-phase iron is important not only for understanding the mineralogy of dust grains but also for investigating grain alignment, since the magnetic properties of dust grains govern the efficiency of their alignment with magnetic fields.

To constrain the nature of solid-phase iron, we investigate magnetic dipole emission from dust grains containing nano-sized magnetic inclusions, such as metallic Fe, magnetite (Fe3O4), and maghemite (gamma-Fe2O3). Owing to ferromagnetic resonance at frequencies of a few GHz, we find that magnetic dipole emission can produce significant centimeter-wave emission from protoplanetary disks. By comparing our models with existing VLA observations, we infer an iron abundance of approximately 10-30% by volume, assuming that all of the observed centimeter emission originates from magnetic dipole emission. In practice, however, contamination from other emission mechanisms, such as free-free emission and spinning dust emission, would reduce the required iron abundance. We argue that high-angular-resolution observations with ngVLA will provide a unique opportunity to spatially disentangle these emission mechanisms and place constraints on the iron form and the abundance of iron in dust grains.

Birth of Massive Stellar Systems: Current Challenges and Prospects for the ngVLA

Roberto Galván-Madrid

IRyA-UNAM

Massive stars are rare, yet they play a dominant role in shaping stellar populations and driving the evolution of the interstellar medium through radiative and mechanical feedback. Furthermore, a large fraction of the star formation rate in the Milky Way occurs within a couple dozen vigorously star-forming molecular clouds, tightly coupling star formation with cluster formation. Current centimeter- and millimeter-wavelength facilities remain unable to resolve key open questions in the field, including: How is mass transferred and distributed across the hierarchical structure from clouds down to disks? How does (proto)stellar feedback ultimately shut off accretion to set the upper limit of the stellar initial mass function? With its superb combination of sensitivity and angular resolution, the ngVLA promises to solve many of these fundamental issues.

The Birth of Massive Stars with the ngVLA: Orbital Movies, Hot-Disk Chemistry, and Protostellar Surfaces

Kei Tanaka

Institute of Science Tokyo

The innermost regions of massive star formation are both hot and dynamic: temperatures rise far above 100 K, dynamical timescales become shorter than a century, and rapidly accreting protostars may expand to au scales. The ngVLA will resolve this largely unexplored regime on scales of 1–10 au. In this talk, I will discuss three compelling science cases, highlighting recent ALMA and VLA results that provide the first glimpses of this future. First, seven-year multi-epoch observations of IRAS 07299−1651 have demonstrated that proper motions, combined with hydrogen recombination-line radial velocities, can constrain the three-dimensional orbit of a massive proto-binary (Wang et al. 2026). The ngVLA will extend this approach to binaries with separations of about 10 au and periods of several years, enabling complete orbital movies. Second, the HOTDISK survey shows that compact rotating disks traced by vibrationally excited H2O and refractory molecules such as NaCl and SiS are common (Yang et al. 2026). Line-transfer and chemical-network models are now beginning to quantify the refractory gas and explain how it forms. With these tracers and models, the ngVLA will probe the kinematics and rocky composition of disks on au scales. Finally, with 1-mas resolution, the ngVLA may take the first direct image of the photospheric surface of a nearby, bloated massive protostar, providing a new test of stellar evolution under high accretion rates.

Feedback from young massive stars across galactic environments

Suinan Zhang

Institute of Science Tokyo

High-mass stars play a key role in shaping the interstellar medium and driving galactic evolution, yet the physical processes regulating their formation are not fully understood. Once a protostar becomes sufficiently luminous, it emits copious amounts of Lyman continuum photons, ionizing and heating up the surrounding medium and giving rise to compact, dense HII regions (UCHII/HCHII). While compact HII regions have been traditionally considered as signposts of the end of mass accretion, theoretical studies suggest that mass growth can continue after an HII region forms, as supported by several recent observational studies. Despite these case studies, it remains unclear whether accretion commonly persists after HII region ignition, how it proceeds in the presence of ionization feedback, and whether high-mass stars can still grow significantly during this phase. In this talk, I will present preliminary results from our ALMA program aimed at resolving compact HII regions and discuss how ngVLA would revolutionize our understanding of high-mass star formation.

Revealing the Nature of the Neutral Atomic Component within the Protostellar Outflows and Jets through the HI 21 cm Emission

Satoko Takahashi

NAOJ

Protostellar outflows and jets play a critical role to remove the excess angular momentum from the accreting material. While protostellar outflow and jet studies have made significant progresses in the last 2-3 decades, mainly through molecular line observations using CO and SiO, the nature of “the neutral atomic wind” remains unclear due to lack of observational data. Indeed, studies of neutral atomic wind (HI wind) are mainly from the 1980s and 1990s at low angular resolution (~1′.0). The next generation Very Large Array (ngVLA) and Square Kilometer Array (SKA) will enable us to image the HI 21 cm emission with appropriate sensitivity and angular resolution, which in turn will reveal the nature of the wind/outflow/jet in the missing neutral atomic component. The HI images obtained with the ngVLA and SKA will be directly compared with the molecular outflow and jet data, which are obtained through millimeter interferometers such as the Atacama Large Millimeter/submillimeter Array (ALMA), at a comparable spatial resolution, velocity resolution, and mass sensitivity. Interaction between the neutral atomic component and molecular component will be directly investigated. This will address whether the HI deceleration wind model proposed by Lizano et al. (1988) is valid, and whether the neutral atomic wind can transfer its momentum to the molecular outflow and jet.

Hydrogen radio recombination lines: Tracing disks, winds and jets in massive young stars

Antonio Martínez-Henares

RIKEN

Hydrogen Radio Recombination Lines (RRLs) are powerful tools for characterising the kinematics and physical structure of the innermost ionized material around high-mass stars. In the past few years, we have studied the radio-continuum and RRL masers observed with ALMA towards the massive star MWC 349A. The modelling with our non-LTE radiative transfer code MORELI has unveiled a jet embedded within a disk wind, which is consistent with MHD disk wind launching models. The detection of these high-velocity features is a direct result of the increased sensitivity of modern observations, a capability that will be substantially enhanced with the advent of the ngVLA. We present predictions of the observability of RRLs with the ngVLA based on our model MORELI. The frequency coverage and angular resolution of the ngVLA will enable the detection of these lines in a large number of objects, allowing us to characterize the full three-dimensional structure and kinematics of winds from massive stars. Finally, we use our model to assess the detectability of RRLs in low-mass objects with the ngVLA, addressing a long-standing observational gap that could provide strong constraints on the photoevaporative winds in their disks.

ngVLA Project Update

Eric Murphy

NRAO

From Stellar Cradles to Disks and Comets: Chemical Inheritance or Reprocessing?

Maria Drozdovskaya

Universität Bern

Prestellar cores and protostellar environments hold the very initial ingredients for protoplanetary disks and the planetesimals that will eventually form in their midplanes. However, are volatile constituents inherited during the processes of star and planet formation? Or are they reprocessed? Observations struggle to provide direct access to disk midplane materials. However, comets are considered some of the most pristine relics from the epoch of active planet formation in our Solar System. They can be used to gauge to what extent volatiles in km-sized planetesimals resemble volatiles found in stellar cradles. In this quest, complex organic molecules are of particular interest as they harbor clues to the exact chemical pathways in their functional groups and isotopic ratios. Moreover, they may have implications for the origins of prebiotic chemistry on habitable planets. Major efforts are currently on the way to systematically characterize the chemical complexity of gases around low-mass protostars, such as the ALMA Large Program COMPASS. Moreover, together with JWST, it is for the first time possible to recover the complete, gas and ice, budget of volatiles in such systems. ngVLA's frequency range is uniquely suited to probe for some of the largest complex organic molecules. Moreover, its spatial resolution will facilitate studies of such species as a function of disk radius. I will highlight the clear synergies between ngVLA and the envisioned capabilities of the ALMA2040 next-generation interferometer in the context of chemical demographics.

Complex Organic Molecules from PDRs to Protoplanetary Disks: New Opportunities with the ngVLA

Viviana Guzmán

Institute of Astrophysics, Pontificia Universidad Católica de Chile

Over the past few decades, ALMA has transformed our view of the chemistry of star- and planet-forming environments. High-angular-resolution observations have revealed that complex organic molecules (COMs) are present not only in hot cores, but also in UV-irradiated photon-dominated regions (PDRs) and protoplanetary disks. However, current observations remain largely limited to the simplest COMs and are increasingly constrained by sensitivity, line confusion, and dust opacity at millimeter wavelengths.

In this talk, I will review recent observational results on complex organic molecules in PDRs and protoplanetary disks, highlighting what has been learned from ALMA and the key questions that remain unanswered. I will then discuss how the ngVLA will transform this field by providing access not only to larger and more complex molecules, but also to low-energy transitions of species already detected with ALMA, such as CH3CN and HC3N, which are better suited to trace the cold gas in PDRs and protoplanetary disk midplanes. The ngVLA will also enable observations of ammonia (NH3), a key tracer of the nitrogen reservoir that is inaccessible to ALMA. Together with its exceptional sensitivity and angular resolution, the ngVLA will provide a unique complement to ALMA, opening a new window on the cold chemistry of star- and planet-forming environments.

Tracing Hidden Nitrogen Reservoirs at the Onset of Planet Formation: Evidence for Ammonium Salt Decomposition

Yoshihide Yamato

RIKEN

The depletion of volatile nitrogen in the dense interstellar medium and in our solar system suggests the presence of hidden nitrogen reservoirs. Recent detections of abundant ammonium salts ($NH_4^+X^-$, where X^- is an acid anion) in comet 67P/Churyumov–Gerasimenko imply that a substantial fraction of nitrogen may be locked into these semi-refractory species, yet their presence and significance in planet-forming environments remain poorly constrained. We present sub-arcsecond (~0.5″) resolution VLA observations of NH_3 emission lines toward the Class 0 protostellar system IRAS 16293-2422, focusing on the circumbinary disk around Source A. Our observations constitute the most comprehensive set of NH_3 lines to date, covering 17 inversion transitions with upper state energies from ~23 to ~1580 K. Using a two-temperature component model, we identify warm (~110 K) and hot (~300 K) emitting components. The former likely traces NH_3 ice sublimation around the protostars, whereas the latter may trace the thermal decomposition of ammonium salts, which are substantially less volatile than neutral ices and release NH_3 together with their acid counterparts upon heating. We support this interpretation with high-resolution (~0.15″) ALMA archival data in Band 3 and Band 4, in which NH_2D and major acidic species, including HNCO and t-HCOOH, show compact emission in a locally heated region. Together, these observations provide the first tentative evidence for the thermal decomposition of ammonium salts, paving the way for a more robust characterization of nitrogen reservoirs in planet-forming disks with ngVLA.

Mapping Embedded Disk Chemistry with ALMA: A Blueprint for Studying Astrochemistry in Planet-Forming Regions with ngVLA

Rajeeb Sharma

National Research Council Canada

Planet formation begins early in embedded Class 0/I disks, whose structure and chemistry are still being shaped by infall, outflows, and strong irradiation. We present the first systematic high-angular resolution (0.1”, ~15 au) view of disk-scale chemistry in 19 nearby embedded protostars from the ALMA Large Program eDisk. Using multi-line observations, we identify the distinct morphologies traced by various species. 12CO and SiO trace outflows and jets, while 13CO and C18O trace the rotating inner envelope and disk regions. The compact hot core regions are traced by DCN and CH3OH, which are predominantly concentrated towards the youngest Class 0 sources. Hydrocarbons are observed in UV-irradiated outflow cavity walls opening near the protostars. SO and H2CO show complex morphology, tracing various structures including non-axisymmetric infall via streamers. These results reveal how various physical structures, temperature, and irradiation set the earliest conditions for planet formation in embedded disks. The upcoming ngVLA will dramatically improve our understanding of the process of star and planet formation by extending observations into the optically thin, mm-cm regime. With ngVLA, we can probe grain growth to cm-sized solids in disk midplanes, obtain ultra-high-resolution (~10 mas) imaging to disentangle dust and free-free emission, and target low-excitation transitions of Complex Organic Molecules and prebiotic molecules at high sensitivities to follow the complex chemistry at a few-au scales. Together, ALMA and ngVLA will link the chemical diversity of embedded disks to the material and conditions available for planet formation.

ngVLA to Sharpen our View of Molecular Complexity at the Earliest Stage of Low-mass Star and Planet Formation

Samantha Scibelli

NRAO

The interstellar medium (ISM) hosts ~350 molecular species, of which nearly half are classified as interstellar complex organic molecules (COMs), defined by at least one carbon atom and six or more total atoms. From single-pointing, single-dish centimeter and millimeter radio surveys, it has become clear that COMs are widespread in starless and prestellar cores. These cores are the cold (~10 K) and dense (~10^5 cm^-3) embryonic clumps of gas and dust that can collapse down due to gravity and external pressure to form low mass (M < a few solar masses) stars and planetary systems. Tracing COMs from this earliest starless and prestellar core phase, through to protostars, planet-forming disks, as well as asteroids and comets, indicates that a significant fraction of the organic inventory may be inherited by planetary building blocks. To help confirm this conclusion and determine precisely where the emission originates, higher resolution observations are essential. New observations from the 100m Green Bank Telescope (GBT) and ALMA Band 1 (both in the ~30-50 GHz range) can spatially (~10-18'' beam) and kinematically (dV ~0.01-0.1 km/s) resolve COM emission toward the prototypical prestellar core L1544, which is on its way to collapse. The findings suggest dynamical processes, such as accretion or infall, from core envelopes may help incorporate COM emission into the forming pseudo-disk. These results strongly motivate the need for ngVLA, which will push to even higher resolutions and sharpen our view of molecular complexity at the dawn of star and planet formation.

Probing the Chemical and Thermal Evolution of Molecular Clouds with CH and OH

Nami Sakai

RIKEN

Understanding how diffuse atomic gas evolves into cold, dense molecular clouds requires probes of both chemical evolution and thermal structure. The ground-state lambda-doubling transitions of CH near 3.3 GHz and OH near 1.7 GHz provide complementary diagnostics accessible in ngVLA Band 1. CH is an intermediate in the gas-phase network from atomic and ionized carbon to CO and thus traces molecular-cloud chemical evolution. Our mapping of Heiles Cloud 2 showed that CH connects the distributions of atomic C and C18O. Its broad and narrow velocity components vary systematically from the diffuse envelope to dense cores. In contrast, non-LTE intensity ratios among the four hyperfine components of the OH 18 cm transition probe gas kinetic temperature over a wide range of H_2 densities. Previous observations revealed warm molecular gas surrounding dense clouds and temperature enhancements associated with external irradiation and a possible filament–filament interaction. These studies have been limited mainly to nearby clouds at about 150 pc and resolutions of 4’-8’. We explore how ngVLA Band 1 could extend them to clouds at 0.3-1.0 kpc and beyond while retaining or improving the physical resolution. Such observations would trace chemical evolution from diffuse gas to CO-bright filaments with CH, while OH would independently constrain temperature variations across filaments, cloud boundaries, and collision interfaces. This science case highlights the importance of Band 1 surface-brightness sensitivity, dense short-baseline coverage, and reliable recovery of extended emission.

CO/HI Studies of Supernova Remnants toward the ngVLA Era

Hidetoshi Sano

Gifu University

Supernova remnants (SNRs) play a fundamental role in the evolution of the interstellar medium (ISM) and galaxies through the generation of shock waves, the injection of heavy elements, and the acceleration of cosmic rays. Over the past two decades, it has become increasingly clear that detailed studies of the inhomogeneous ISM surrounding SNRs, traced by molecular (CO) and atomic (HI) gas, are essential for understanding physical processes across a wide range of spatial and energy scales. These include the origin of thermal- and non-thermal X-ray and gamma-ray emission, particle acceleration and transport, shock-driven interstellar chemistry, and the formation of filamentary molecular clouds that serve as the birthplaces of stars.

In this talk, I will review major advances achieved through CO and HI observations with radio facilities including ALMA, NANTEN2, NRO45, ASTE, and their complementary instruments over the past quarter century. I will then discuss how the ngVLA will transform studies of SNR-ISM interactions by providing unprecedented sensitivity, angular resolution, and imaging fidelity. The ngVLA will enable detailed investigations of shock-cloud interactions, cosmic-ray acceleration mechanisms, magnetic field amplification, and the multi-phase structure of the ISM, opening a new era in our understanding of the dynamic interplay between stellar explosions and their surrounding environments.

Molecular Evolution across Diverse Birth Environments: An ngVLA Perspective

Takashi Shimonishi

Niigata University

Recent observations with ALMA and JWST have extended studies of interstellar molecules associated with star- and planet-forming systems to increasingly diverse environments. These include regions with physical and chemical conditions substantially different from those in the solar neighborhood. Understanding star and planet formation and chemical evolution under such conditions is essential for testing whether the picture established in the solar neighborhood is universal across different galactic environments and throughout cosmic history.

In this talk, I will first present recent observational studies of molecular complexity of protostars in two distinct birth environments: low-metallicity regions and supernova-feedback regions, with a particular focus on complex organic molecules. For the former, protostars in the Magellanic Clouds and the outer Galaxy provide laboratories for studying molecular evolution at low metallicity. These environments offer insights into molecular chemistry under conditions relevant to the past Milky Way and high-redshift galaxies. For the latter, protostars within a supernova remnant provide a unique opportunity to investigate how extreme stellar feedback, including powerful shocks and enhanced cosmic rays, affects the molecular evolution of star-forming cores. Such environments may also provide insights into the possible birth environment of our own Solar System. Both provide unique laboratories for exploring how birth environments shape molecular evolution during star and planet formation.

I will then discuss new opportunities with the ngVLA for studying molecular evolution across diverse birth environments. Its unprecedented sensitivity, angular resolution, and frequency coverage will enable observations that are highly complementary to those with ALMA, including searches for larger molecules, carbon-chain species, and aromatic molecules in compact sources; measurements of the temperature structure of parent clouds using molecular thermometers (e.g., NH3); diagnostics of elemental composition and radiation fields using small radical species (e.g., CH and OH); and constraints on magnetic fields and cosmic-ray environments. By providing new chemical and physical diagnostics that are difficult to access with existing facilities, the ngVLA will offer a new perspective on a fundamental question: What environmental conditions lead to chemically rich star- and planet-forming systems?

The Galactic Center Millisecond Pulsar Search: Progress and Prospects

Joanna Berteaud

Royal Holloway University of London

Six decades after their discovery, astronomers continue to find new pulsars at an ever-growing rate. Interestingly, this trend also holds toward the inner Galaxy, where a long-standing hypothesis predicts a large population of millisecond pulsars. Observing and studying these fast-spinning neutron stars is highly valuable for probing the interstellar medium, understanding stellar evolution, and testing theories of gravity. Moreover, their discovery is particularly relevant for uncovering the origin of the Galactic center excess—a puzzling diffuse gamma-ray emission whose source remains debated. These strong motivations, combined with new instruments and observing strategies, have led to the recent identification of several millisecond pulsars with high column densities of free electrons, suggesting bulge distances. These discoveries challenge recent population models of millisecond pulsars that include only a single component in the Galactic disk. Are we witnessing the first statistical evidence for Galactic bulge millisecond pulsars? What does the future hold for the Galactic center millisecond pulsar search? In this talk, I will report on recent developments in the field and discuss persistent key challenges and emerging science cases, as well as potential new avenues for the ngVLA era.

Probing Extreme Physics with ngVLA Millisecond Pulsar Timing

Thankful Cromartie

Vanderbilt University

Observations of millisecond pulsars (MSPs) with large radio telescopes are a powerful tool for probing fundamental physics in a manner that is inaccessible to laboratory experiments. High-precision radio timing of massive MSPs, especially those with well-measured post-Keplerian effects such as the relativistic Shapiro delay, provides direct constraints on the dense matter equation of state, as valid models must account for neutron stars exceeding ~2 solar masses. Pulsar timing also facilitates stringent tests of general relativity in the strong-field regime with relativistic neutron star binaries and provides insight into the nature of gravitational waves through long-timespan pulsar timing array experiments. These studies will be revolutionized by high-sensitivity next-generation radio facilities such as the ngVLA. This talk will review recent dense matter equation of state and general relativistic constraints from radio MSP timing, specifically exploring expected gains from the high sensitivity and favorable frequency coverage offered by the ngVLA. The ngVLA's role in pulsar timing array observations, as well as anticipated synergies with other observatories (radio and otherwise), will also be discussed.

Cosmic birefringence and forthcoming radio surveys

Fumihiro Naokawa

Tohoku University

Cosmic birefringence, a systematic rotation of polarization plane of photons, is a potential signal of dark energy, dark matter and axion-like particles, and has been recently reported from CMB observations (Komatsu 2022). However, CMB observations alone still face several observational challenges in confirming the signal and determining its origins. As a solution, independent tests using astrophysical polarized sources, such as radio galaxies, are expected to play an important role。 In this talk, I will review the current status, and discuss how the other future surveys like ngVLA will make importantly contribute this field.

Nanohertz gravitational-wave astronomy enabled by VLBI astrometry

Keitaro Takahashi

Kumamoto University

Pulsar timing arrays (PTAs) have found evidence for a nanohertz gravitational-wave (GW) background, and the next goal is to detect individual supermassive black hole binaries (SMBHBs). The main problem is localization: PTA searches give sky areas of tens to hundreds of square degrees, which contain far too many candidate galaxies. The cause is geometric. The PTA response has an Earth term and a pulsar term, and poorly known pulsar distances make the pulsar-term phase a free parameter, which weakens the triangulation.

Our simulations show that external distance priors fix this. If a pulsar distance is known to better than one GW wavelength (about 1 pc), the pulsar-term phase is determined. Only a few such pulsars improve the localization by one to two orders of magnitude, reaching about 10^(-3) deg^2 in a favorable geometry, small enough to pick out a unique host galaxy.

This requires parallaxes of about 10 microarcseconds for millisecond pulsars within a few hundred parsecs. The ngVLA, with its long baselines, high sensitivity, and multi-calibrator capability, is well suited to this, and I will propose a program for nearby PTA pulsars such as J0030+0451, J1744-1134, and J2145-0750. The SKA will cover southern targets such as J0437-4715.

The ngVLA is also valuable after the host galaxy is found. Its milliarcsecond imaging can search the nucleus for a compact radio core, a dual AGN, or jet precession driven by the binary orbit. Such data would constrain the accretion state and the gas environment that drives the orbital decay.

Precise Measurements of the CMB Temperature at z=0.68, 0.89, and Beyond Using Molecular Absorption Lines

Tatsuya Kotani

Keio University

In the standard cosmological model, the cosmic microwave background (CMB) temperature evolves with cosmic time as T_CMB(z) = T_0(1+z), where T_0 = 2.7255 K is the present-day temperature. While measuring T_CMB toward distant galaxies critically tests standard cosmology, observational constraints remain scarce at high redshifts (1<~z<~2 and z>~3). Excitation analysis of molecular absorption lines provides a powerful direct probe of T_CMB due to dominant radiative excitation by the CMB in intervening foreground absorbers. Using ALMA archival data, we derived record-precision CMB temperatures toward two intervening absorbers: T_CMB = 4.50±0.17 K at z=0.68 (B0218+357) and 5.13±0.06 K at z=0.89 (PKS1830-211), using multiple rotational transitions of polar molecules (HCN, HCO^+, HNC). To extend constraints to higher redshifts, we are conducting new ALMA and JVLA molecular absorption searches at z=1.4 (toward PKS1406-076) and z=3.4 (toward PKS0201+113). These observations aim to fill the unprobed 1<z<2 gap and surpass the previous redshift record for this method (z=3.3). Furthermore, the high sensitivity, spatial resolution, and broad frequency coverage (cm to mm) of the ngVLA will enable component-resolved detections of faint absorption at even higher redshifts. This will yield precise T_CMB constraints at 1<~z<~2, z>~3, and unexplored regimes at z>6.5, tightening cosmological model constraints by more than a factor of three. In this presentation, we detail our recent T_CMB measurements, present the current status of our absorption searches, and discuss future prospects for high-redshift T_CMB determinations with the ngVLA.

Exploring the Dynamic Universe in the ngVLA Era

Kunihito Ioka

Kyoto University

The ngVLA will provide a powerful new view of the dynamic Universe, with unprecedented sensitivity, angular resolution, and rapid response capability for transients and variable sources. I will present a theoretical perspective on the key questions that future radio observations can address in the era of multi-messenger astronomy. In particular, I will discuss how ngVLA will reveal the physics of relativistic outflows from compact objects, including neutron star mergers, gamma-ray bursts, magnetars, and fast radio bursts, as well as the growth and feedback of supermassive black holes. These studies will shed light on the ultimate fate of gravitational energy in the Universe.

Multi-AGN in the Radio Regime: Progress, Challenges, and the ngVLA

Emma Schwartzman

U.S. Naval Research Laboratory

Since the confirmation of 3C 75, radio observations have been indispensable for identifying and confirming multiple active galactic nuclei (multi-AGN). They provide the highest angular resolution available with existing observatories, direct access to the compact synchrotron emission associated with accreting supermassive black holes throughout the merger process, and are largely insensitive to dust obscuration. Advances with facilities such as the VLA and VLBA, together with numerous radio surveys, have enabled systematic searches for multi-AGN spanning kiloparsec to parsec scales, while multiwavelength selection techniques have substantially expanded the pool of promising candidates. Nevertheless, confirmed systems remain rare, reflecting fundamental challenges in sensitivity, angular resolution, source identification, and distinguishing true multi-AGN from complex jet morphologies, gravitational lenses, and other astrophysical contaminants.

In this talk, I will review the current landscape of radio-selected, radio-supported, and radio-confirmed multi-AGN, highlighting recent observational progress, outstanding challenges, and the complementary role of radio observations in the broader multiwavelength discovery framework. I will then discuss how the ngVLA is poised to transform this field. Its combination of enhanced angular resolution, order-of-magnitude improvements in sensitivity, broad frequency coverage, and long-baseline capabilities will enable statistically meaningful surveys of dual and multiple AGN, resolve binaries at previously inaccessible separations, characterize compact cores and jets with unprecedented fidelity, and strengthen connections to current and future gravitational-wave experiments. Together, these capabilities will move the field beyond the discovery of individual systems toward a comprehensive census of merging supermassive black holes, while opening a new window onto binaries at separations that remain beyond the reach of existing facilities.

Searching for Intermediate Mass Black Holes with Radio Imaging

Krista Lynne Smith

Texas A&M University

The mass distribution and occupation fraction of intermediate mass black holes (IMBHs) in low-mass galaxies are key observables touching on fundamental questions from the nature of gravity to the assembly of large-scale structure in the Universe. Because low-mass black holes are relatively faint emitters even when accreting at maximal rates, effective methods for their detection are challenging and often beset by degeneracies. High resolution, high sensitivity, multiband radio imaging represents one of the best prospects for an effective search. I will discuss the current state of the field in IMBH searches, and summarize some recent new results. I will also discuss how the capabilities of the ngVLA will enhance this field substantially, along with multiwavelength and multi-messenger implications.

Radio-loud Black Hole Candidates Driving Molecular Jets in the Galactic Center

Shunya Takekawa

Kanagawa University

Our Galaxy is expected to contain a vast population of black holes, yet only a small fraction have been identified. While X-ray binaries and gravitational microlensing have been the primary discovery channels, black holes in dense molecular gas remain largely unexplored. Molecular gas may provide a new way to identify hidden black holes through both gravitational interactions and jet-cloud interactions.

We have recently identified three compact radio continuum sources associated with high-velocity compact clouds (HVCCs) in the Central Molecular Zone. Each source exhibits nonthermal radio emission and is likely to drive a bipolar molecular jet or outflow. Their unusually high radio luminosities relative to their X-ray upper limits, together with the absence of luminous infrared or dust counterparts, make them strong radio-loud black hole candidates. The common radio and molecular morphology among the three systems suggests that they may represent a previously unrecognized population of black holes embedded in dense molecular clouds.

In this talk, I will present these newly identified systems and discuss their implications for future black hole searches. The ngVLA will resolve compact radio jets and probe the surrounding gas kinematics, opening new opportunities to identify black holes through both jet-driven feedback and gravitational signatures, including intermediate-mass black hole candidates. These capabilities will establish molecular gas as a powerful probe of the hidden black hole population in our Galaxy.

Radio Probes of Galactic PeVatrons: Jet–Cloud Interactions in SS 433

Haruka Sakemi

Yamaguchi University

The growing number of Galactic sources detected at TeV–PeV energies is opening a new window on extreme particle acceleration. Identifying the accelerators, however, requires more than gamma-ray detections alone. Radio observations can directly probe synchrotron-emitting particle populations and their magnetic fields, while spectral-line observations trace the surrounding interstellar gas and its interaction with the accelerator. Together, these measurements provide a powerful means of connecting high-energy emission to the underlying acceleration physics.

In this talk, we will discuss SS 433 as a nearby laboratory for studying these processes. We will present our recent discovery of molecular clumps directly associated with the rebrightening regions of its large-scale X-ray jets, based on 12CO(J=1-0) observations with the Nobeyama 45 m Telescope. The X-ray emission peaks immediately downstream of the CO emission peaks, while regions of high X-ray hardness are also spatially offset from the molecular clump peaks. These spatial relationships provide evidence for jet–cloud interactions, in which jet-driven turbulence amplifies magnetic fields and enhances nonthermal synchrotron emission.

More broadly, the combination of radio synchrotron imaging, spectral and polarization measurements, and observations of atomic and molecular gas will be essential for characterizing Galactic PeVatron candidates. We will discuss how the sensitivity, angular resolution, and broadband capabilities of the ngVLA can reveal particle acceleration, magnetic-field structures, and interactions with the surrounding medium, providing a critical bridge between radio and TeV–PeV gamma-ray observations.

An Extreme Velocity-Width Molecular Structure in the Supernova Remnant W44: Possible Evidence for a Compact Object Plunge

Momoko Makita

Keio University

The supernova remnant W44 is interacting with a giant molecular cloud of ~3x10^5 Msun. In this interaction region, a compact (~0.5 pc) molecular cloud (the “Bullet”) exhibits an extremely broad velocity width reaching ~120 km/s. The Y-shaped position–velocity structure of the Bullet is consistent with a high-velocity plunge of a massive compact object into a dense molecular layer. ALMA CO J=3–2 observations further revealed eight similar components, termed “Petit-Bullets,” suggesting that the plunging object may have been a group of compact objects. Momentum analysis of the Bullet has also suggested an isolated black hole as a possible plunging object. New ALMA observations detected the dense gas tracers HCO+ and HCN toward the Petit-Bullets. The dense gas is concentrated in the high-velocity components, supporting localized gas compression consistent with the compact object plunge scenario.

The ngVLA will enable deep radio continuum searches for the candidate compact object responsible for the Bullet. Detecting, or placing stringent upper limits on, faint radio emission associated with interstellar medium accretion would provide a unique constraint on the nature of the proposed isolated black hole. In addition, W44 hosts compact OH (1720 MHz) maser spots, while recent studies suggest diffuse low-brightness OH maser emission across the remnant. ngVLA observations of OH masers will reveal the shocked molecular environment in W44 and help clarify the conditions under which extreme velocity-width molecular structures form.

A Deep Radio Test of the White-Dwarf Termination Shock in the SN 1181 Remnant

Norihiro Yamada

The University of Tokyo

SN 1181 is one of the best Type Iax supernova remnants for detailed study because of its proximity within the Milky Way. Type Iax supernovae are a subclass of thermonuclear supernovae that are less luminous than normal Type Ia supernovae. While Type Ia supernovae are widely believed to result from complete thermonuclear explosions of white dwarfs, Type Iax supernovae are thought to arise from incomplete explosions that leave behind a bound white dwarf remnant. Studying these surviving white dwarfs provides a rare opportunity to constrain the progenitor systems and explosion mechanisms of Type Iax supernovae, offering important clues to the long-standing mystery of Type Ia progenitors.

The remnant of SN 1181, Pa30, is especially valuable because a surviving white dwarf has been identified at its center. This star drives an exceptionally fast wind with a velocity of about 15,000 km/s. Pa30 also has an unusual central region, 0.8 arcsec (0.0086 pc) in radius, that is bright in thermal X-rays. Ko et al. (2024) proposed that this emission originates from particles heated and accelerated at the termination shock formed by the interaction between the white dwarf wind and the supernova ejecta. Detecting synchrotron emission from this compact region would strongly support this model.

We searched for the predicted synchrotron emission with the VLA. Despite 7.5 hours of on-source integration, no extended emission was detected from the central 0.8 arcsec region. Instead, only a marginal point source with a signal-to-noise ratio of about 3 was found slightly offset from the center. Future observations with the ngVLA, providing much higher sensitivity and resolution, will be essential to detect the synchrotron emission and resolve its spatial distribution.

Insights from a Systematic VLA Monitoring Program of Tidal Disruption Events

Collin Christy

University of Arizona

When a star strays too close to a supermassive black hole, gravity rips it apart in a violent event called a tidal disruption event (TDE). As the star's debris falls into the black hole, it illuminates an otherwise dormant galactic center providing a rare, real-time probe of accretion physics and the environments of otherwise quiescent galactic nuclei. Yet their properties at radio wavelengths have remained poorly understood. Here, we present four years of systematic VLA monitoring of a uniformly-selected sample of TDEs, the most comprehensive radio campaign for TDEs to date. Our multi-frequency observations span weeks to years post-discovery, enabling the first consistent, population-level analysis of TDEs in the radio. By modeling the radio light curves and broadband spectra of each event, we constrain the physical properties of their outflows and find substantial diversity across the sample. Additionally, we place the first statistical constraints on the fraction of TDEs producing detectable radio emission, finding that radio outflows are a common but not ubiquitous feature of the population. These results establish uniform, long-term monitoring as an essential probe for disentangling the diversity of TDE outflows and linking their real-time radio behavior to the evolving accretion physics that drives them.

VLBI Observations of the Enigmatic Optical Tidal Disruption Event AT2018hyz

Walter Golay

Center for Astrophysics | Harvard & Smithsonian

We present new very-long-baseline interferometry (VLBI) imaging and astrometry of the tidal disruption event (TDE) AT2018hyz, which was initially detected in the radio ~2.2 years after the optical flare despite previous non-detections. Since then, it has rapidly risen at all frequencies spanning at least ~1-20 GHz and at one point rose as fast as L~t^5.7. AT2018hyz has since reached a peak luminosity of 10^40 erg/s, comparable to the on-axis jetted TDE Sw J1644+57 on similar timescales. The multi-frequency spectral energy distribution modeling of the synchrotron-emitting outflow could be consistent with either a non-relativistic, quasi-spherical outflow launched 620 days post-disruption or a highly off-axis (>80 degrees) relativistic jet, both of which could explain the delayed onset of radio emission. Our new VLBI observations spanning the previous three years of AT2018hyz's radio flare, using the High Sensitivity Array and the Very Long Baseline Array, are providing new evidence to distinguish between these two scenarios. We will present this new dataset and discuss the potential resolved nature and astrometric motion of the source.

Exploring SMBH Feeding and Feedback with Millimeter and X-ray Observations

Taiki Kawamuro

The University of Osaka

Understanding SMBH feeding and feedback requires tracing how gas reaches the black hole, powers the central engine, and is subsequently affected by the released energy. X-ray and millimeter observations provide complementary views of this cycle, from the hot accretion flow to the cooler gas surrounding the nucleus.

I will present recent joint millimeter and X-ray studies of nearby AGNs. I will first discuss the connection between compact millimeter and X-ray emission and what it reveals about the hot corona, where accretion energy is converted into high-energy radiation. Motivated by this observed connection, I will explore the potential of compact millimeter emission as a tracer of intrinsic AGN activity. Because millimeter emission is only weakly affected by obscuration, this approach offers a complementary way to uncover growing SMBHs that may be missed by X-ray surveys, including heavily obscured and dual AGNs. I will then present spatially resolved observations of radiative feedback, showing how AGN X-ray irradiation heats, ionizes, and alters circumnuclear gas. Finally, I will highlight how the ngVLA, together with current and future X-ray missions, can advance our understanding of SMBH feeding and feedback.

Connecting the UV and infrared views of galaxy evolution: challenges for models and opportunities for ngVLA

Laura Sommovigo

Columbia University & CCA

HST, Spitzer, Herschel, ALMA, and now JWST have assembled an unprecedented multi-wavelength census of galaxies across cosmic time. In parallel, galaxy evolution modelling has advanced rapidly: cosmological simulations now resolve increasingly detailed ISM physics, radiative-transfer post-processing produces realistic synthetic observations, and simulation-based inference allows models to be confronted directly with data. Yet a key challenge remains. The rest-frame UV and infrared often tell different stories — from the wide scatter in dust attenuation and infrared excess among otherwise similar galaxies, to the puzzling transition from UV-bright, apparently dust-poor galaxies at $z>10$ to dust-rich systems only a few hundred million years later. The models we use to connect these wavelengths depend critically on assumptions about dust across scales, from grain properties to the structure of star-forming clouds and the dust–star geometry of whole galaxies, and these assumptions propagate directly into our inferences on star formation, stellar mass, and feedback. I will review recent progress and open problems in modelling dust and galaxy evolution across wavelengths, and discuss how the ngVLA's unprecedented sensitivity and angular resolution could help break these degeneracies -- by tracing cold gas and star formation independently of dust, and by resolving the internal structure of distant galaxies -- opening new science cases at the interface between models and observations.

Witnessing the phase transition dynamics from the diffuse HI to molecular clouds and its metallicity dependence in MHD simulations

Masato Kobayashi

National Institute for Fusion Science

Latest observations toward nearby galaxies have covered nearly the full extent of HI and CO of each galaxy, which highlight the importance of the transition from diffuse HI to dense CO clouds to initiate star formation. It is also known that the cosmic star formation peaked at redshift 2-3, but it is still challenging to resolve individual CO clouds at such high redshifts. Therefore, it is timely and key to understand the evolution of the local ISM as an analog of such star formation activity in nearby and high-redshift galaxies.

We have been performing a series of high-resolution MHD simulations of molecular cloud formation in shock-compressed diffuse HI by employing the spatial resolution of 0.02 pc. We investigated the metallicity dependence by varying the metallicity from the Solar to 0.1 Solar value. Our simulations find that magnetic fields play more crucial role in lower metallicity environments due to MHD shear flows along magnetic fields. As a result, molecular cloud formation and star formation predominantly occur only in highly compressed regions (high-ram pressure regions) at metallicities below 0.2 Solar value. This naturally explains that galaxy-galaxy mergers and cosmological gas accretion onto galaxies accumulate mass quickly and drive active star formation at high redshifts, while galaxies at the present-day form stars only gradually but rather everywhere.

This picture can be tested with ngVLA in the Milky Way and the Magellanic Clouds in HI and OH and thus we will discuss the strategy of such observations at the end of this presentation.

Disentangling Colliding Gas Flows in Merger-Driven Starbursts: An Automated Spectral Decomposition Framework for the ngVLA Era

Tomonari Michiyama

Shunan University

Galaxy mergers host the most extreme star formation in the local Universe, where cloud–cloud collisions are thought to trigger the birth of super star clusters. Testing this scenario requires measuring the morphology and kinematics of each colliding gas component individually; yet along such sightlines multiple velocity components overlap, and conventional moment analysis breaks down: the first moment traces no physical structure, and the second conflates internal dispersion with the separation between components. This limitation is already evident in ALMA observations, and it will become ubiquitous with the ngVLA, whose wide-field, high-sensitivity, high-velocity-resolution cubes of the molecular and atomic ISM will contain 10^5–10^6 spectra that demand automated, objective, and reproducible analysis. We present a framework designed for this regime, in which line-profile shapes are first classified in an unsupervised manner (PCA + k-means), and this classification then guides an objective multi-Gaussian decomposition whose component number is set by model selection (BIC), with no manual masking or per-pixel intervention. Applied to the ALMA CO(1–0) cube of the Antennae galaxies, it recovers spatially overlapping velocity systems with distinct morphologies and kinematics that are blended in the observed moments, consistent with an ongoing collision driving the starburst in the overlap region. Classification-guided, reproducible pipelines of this kind will be essential for extracting the physics of star formation from kinematically complex ISM in the ngVLA era, from CO and dense-gas tracers to HI.

Tracing the Faint and Diffuse Universe with the ngVLA: High-Redshift Galaxies, Protoclusters, and Dark Matter

Kotaro Kohno

The University of Tokyo

Understanding the faint and diffuse components of the high-redshift Universe is essential for tracing the thermal history of protoclusters, cold gas around galaxies, and dark matter in galaxy dynamics. The ngVLA will provide a unique combination of sensitivity, angular resolution, and spatial-scale coverage to address these questions. First, I will discuss the thermal Sunyaev-Zel'dovich effect (SZE) as a probe of hot gas in forming protoclusters. Recent observations suggest substantial thermal energy may already be present at $z>4$, while our deep ALMA Band 3 study of a $z>3$ protocluster provides complementary constraints on its thermal state. Together with recent reports of diffuse X-ray emission at higher redshift, these results motivate extending SZE measurements toward the earliest stages of cluster assembly, where sensitivity to extended emission and short spacings will be crucial. I will then turn to cold gas around and within high-redshift galaxies. Our CO(1-0) observations of a $z=5.2$ radio galaxy reveal massive molecular reservoirs extending tens of kiloparsecs beyond the host. Spatially resolved low-J CO with the ngVLA can provide an independent kinematic view of the cold molecular reservoir, complementary to ALMA [C II], and help constrain the dark-matter contribution by comparing different gas phases and potentially tracing rotation curves to larger radii. I will briefly discuss how sensitivity to diffuse radio emission may also enable indirect WIMP searches in dwarf spheroidal galaxies. These examples highlight the synergy among the ngVLA, ALMA, and large single-dish telescopes in tracing the faint and diffuse Universe.

Probing Thermal Radio Continuum Emission with the ngVLA in Star Forming Galaxies

Tirth Surti

California Institute of Technology

Radio continuum emission from star forming galaxies (SFGs) is a promising dust-unbiased tracer of star formation, as its thermal free-free component is directly related to the star formation rate. However, separating thermal emission from non-thermal synchrotron emission in SFGs remains a challenging problem. Thermal radio contributions in SFGs are not well understood beyond the typical Milky-Way like galaxy in the local universe, which exhibits a ~10% thermal fraction at 1.4 GHz. Using dust-corrected integrated Hα luminosities, we show that the thermal fraction at 1.4 GHz of local SFGs decreases by ~1 dex as the total radio luminosity at 1.4 GHz increases from 10^(20) to 10^(22.5) W/Hz. We propagate this calibration through models of cosmic-ray losses to predict a redshift-evolving thermal fraction at fixed total radio luminosity. The ngVLA can provide independent tests of these models at both the individual galaxy and population levels. Its microjansky sensitivity from 1–90 GHz will constrain thermal fractions in SFGs across luminosity and redshift. Additionally, confusion-limited surveys (e.g., with the spiral+outerCore subarray of the ngVLA) can measure 1.4 GHz source counts down to a few hundred nanojansky, thus constraining the radio luminosity function evolution of SFGs out to z~2-3. Applying our models to convert the resulting radio luminosity functions into star formation rate densities will yield a cosmic star formation rate history whose comparison with existing non-radio determinations will provide another test of these models.

Disk formation and evolution from the first galaxies to present

Takafumi Tsukui

Kavli IPMU

Almost all stars in the Universe form in galactic disks, so understanding how disks develop structurally and chemically is central to understanding galaxy formation. The Milky Way's thick disk is particularly important because it probes how the Galaxy first formed its disk. ALMA and JWST now allow us to directly observe the development of thick and thin disks in distant galaxies, although current ALMA observations are limited in sensitivity relative to JWST for galaxy populations matched in SFR and stellar mass. I will present recent insights from the observations and theoretical modeling, and discuss how the gas component shapes disk structure and how the ngVLA will improve our understanding of disk formation by characterizing the distribution and kinematics of molecular gas and the dust temperature distribution in direct Milky Way progenitors.

Is Radio Emission a Reliable Star-Formation Tracer in the Early Universe?

Eric F. Jimenez-Andrade

IRyA-UNAM

Although radio emission has long been established as a robust tracer of dust-obscured star formation in galaxies, the conditions of the early Universe may fundamentally alter the radio emission process. If so, the calibration of radio continuum emission as a star-formation-rate (SFR) indicator may need to be revisited. Using the 3 GHz radio surveys of the EGS and GOODS-N fields obtained by our team, we investigate how the 1.4 GHz radio luminosities of UV-selected star-forming galaxies evolve with redshift. We find that, for a fixed SFR, the 1.4 GHz radio luminosity decreases with increasing redshift. This trend is broadly consistent with the predicted suppression of synchrotron emission due to inverse Compton losses off the cosmic microwave background. We also discuss other effects contributing to the observed evolution, including a top-heavy initial mass function, evolving radio spectral indices, and the shift to progressively higher rest-frame frequencies at fixed observing frequency with increasing redshift. The latter also affects the observed radio morphologies of galaxies. Using multi-frequency radio observations in GOODS-N, we find that galaxy radio sizes depend systematically on emitted frequency, revealing a significant morphological K-correction. We discuss the implications of these findings for future galaxy-evolution studies with the Next Generation Very Large Array and other deep radio continuum surveys.

When Did Dust Turn the Universe Dark? ngVLA and ALMA2040 combining to find the answer

Tom Bakx

Chalmers, University of Technology

JWST has pinned the unobscured cosmic star-formation history well into the first few hundred million years, yet the dust-obscured part is still uncertain by over two orders of magnitude at z = 8. The culprit is one unmeasured quantity: with L_IR proportional to T^(4+beta), every high-z census inherits the uncertainty of an assumed dust temperature. In my talk, I will discuss the implications by comparing a galaxy at z = 8.31 forming 93% of its stars behind ~91 K dust against deep dust limits from ten z > 8 galaxies with obscured fractions below 0.3. That scatter in dust content alone obfuscates our estimate for the importance of obscured (cosmic) star-formation rate by billions of years.

In parallel, the ngVLA will provide dust-free measurements complementing our best estimates from ALMA. At z = 6-10 its low-frequency bands land on rest-frame thermal free-free emission, giving the first extinction-independent star-formation rates inside reionization, and 70-116 GHz recovering cold dust masses, while low-J CO sets the gas reservoirs and the duty cycle of the warm starburst phase, and its high-resolution (sub-10 mas) imaging can resolve star formation on ~100 pc. Linking these capabilities with the competences of present ALMA and future ALMA2040 (5-10x sensitivity, sub-10 mas imaging, simultaneous multi-band observing, hybrid arrays), future ngVLA, SKA-Mid and DSA-2000 studies will provide deep the necessary ionizing budget and cold gas to push a dust-free census past z = 10, revealing the build-up of the earliest galaxies, and underpinning the exciting results from the JWST era.

Can Radio Observations Reveal What Powers the James Webb Space Telescope's Little Red Dots?

Jackson Wetherbee

University of Massachusetts Amherst

Little Red Dots (LRD) are a new classification of high-redshift sources discovered by the James Webb Space Telescope (JWST). The nature of these sources is still unknown, as they exhibit traits similar to those of an Active Galactic Nucleus (AGN). They however fail to exhibit certain traits that are characteristic of an AGN, and other origins are also plausible, such as massive star clusters. Here we will discuss the results of a stacking analysis of the 1000 hr 1.4 GHz VLA program (CHILES Con Pol) data and show what the resulting next-generation Very Large Array (ngVLA)-like sensitivity yields about the radio properties of LRDs (in terms of their AGN power and star formation rate). This work should serve as a compelling science case for the ngVLA. The ngVLA's substantially improved sensitivity will enable significantly deeper measurements of radio emission from LRD and other new and established galaxy populations across cosmic time. Such observations should provide critical new constraints on AGN activity and star formation, helping to resolve the origin of one of JWST's most intriguing new populations.

Probing the Blazar Sequence at Millimeter Wavelengths with the ngVLA

Kanako Narita

The University of Tokyo

Blazars provide the most direct view of relativistic jets powered by supermassive black holes, making them ideal laboratories for understanding how jets are accelerated, radiate, and evolve. Although the blazar sequence has long served as a unifying framework for blazar diversity, its physical origin remains an open question. Previous studies have focused primarily on broadband spectral energy distributions (SEDs), while the role of millimeter synchrotron emission has remained largely unexplored.

Using the FALCON (Fermi–ALMA Calibrator ObservatioN) Survey, constructed by cross-matching the ALMA Calibrator Source Catalogue with the Fermi-LAT 4LAC-DR3 catalog, we present the first statistical evidence that the blazar sequence extends into the millimeter regime. Both the millimeter spectral index and the redshift-controlled millimeter–gamma-ray luminosity correlation vary systematically from FSRQs to HSP BL Lac objects, demonstrating that millimeter synchrotron emission directly reflects the physical evolution of relativistic jets.

These results raise a fundamental question: what drives the blazar sequence? The ngVLA will provide the broadband frequency coverage and polarization sensitivity needed to answer this question by measuring synchrotron turnover frequencies, spectral curvature, optical depth, magnetic-field ordering, Faraday rotation, and depolarization across blazar subclasses. I will present the FALCON results and discuss how ngVLA observations can turn this statistical trend into a physical understanding of the blazar sequence.

Resolving the Molecular ISM in the Cloverleaf Quasar: From ALMA Mid-J Lines to ngVLA Ground-State Transitions

Yuri Nishimura

University of Tsukuba

We present a spatially resolved molecular-line study of the strongly lensed Cloverleaf quasar at z=2.56, probing the interstellar medium of a quasar host at cosmic noon. Deep ALMA observations cover mid-J transitions of CO, HCO+, HCN, CN, and other species, while gravitational magnification enables sub-kpc source-plane reconstruction. CO(3–2) and HCO+(4–3) reveal a rotating, gas-rich molecular disk. In contrast, HCN(4–3) and CN(3–2) show distinct spatial distributions and peak toward the component brightest in the X-ray and mid-infrared, suggesting that these species trace dense gas whose chemistry and excitation are influenced by energetic radiation and/or shocks. Vibrationally excited HCN is not detected, consistent with a less deeply buried nucleus, although deeper data are required. The non-detection of CS may indicate that energetic radiation and/or shocks strongly influence the nuclear chemistry.

These results demonstrate the power of spatially resolved multi-line observations for connecting local luminous infrared galaxies to quasar hosts at high redshift. However, interpretations based only on mid-J lines remain sensitive to excitation and tracer-dependent differential lensing. Future ngVLA imaging of the ground-state J=1–0 transitions of CO, HCN, and HCO+ would directly trace the low-excitation molecular reservoir, anchor molecular- and dense-gas-mass estimates, and distinguish genuine chemical differentiation from excitation effects. Combining ALMA and ngVLA observations will provide a more complete, spatially resolved census of the multiphase molecular ISM during the peak epoch of galaxy and black-hole growth.

[OI] 145um Constraints on the Dense Neutral ISM and Outflow of the z = 6.04 Quasar J2054-0005

Mahoshi Sawamura

The University of Tokyo

We present deep ALMA observations of the [OI] 145um line in the luminous z = 6.04 quasar J2054-0005, using two independent datasets: (1) deep moderate-resolution (~0''.5, ~30 sigma) detection and (2) separate high-resolution (~0''.1) imaging. Characterizing quasar-driven outflows is crucial as they regulate star formation and shape galaxy evolution. While [CII] 158um is the standard probe of cool ISM in z > 6 galaxies, broad [CII] outflow wings are rare. In contrast, blueshifted OH 119um absorption is seen in ~70% of luminous quasars. This discrepancy poses a working hypothesis that neutral outflows reside in gas much denser than the [CII] critical density, motivating us to perform deep [OI] 145um line (~10x higher critical density) observations. The luminous z = 6.04 quasar J2054-0005 is an ideal test case: its [CII] profile shows no outflow signature, while deep OH absorption is clearly detected. Our deep [OI] spectrum is fully characterized by a single Gaussian, so [OI] also fails to trace the OH outflow. Thus, the outflow must be denser still, or too low-mass to appear in emission. The high-resolution data let us map spatial photodissociation-region (PDR) properties and assess X-ray dissociation-region (XDR) contributions, breaking degeneracies by combining [OI] with matched-resolution archival [CII] and FIR continuum data. The ngVLA will complete this picture by directly mapping cold, dense molecular gas (e.g., CO, HCN) at comparable resolution. We perform ngVLA mock observations to assess detection limits of diffuse and dense gas tracers, investigating the ability to constrain the OH outflow's origin.

Neutral Gas Structure in a z = 7.88 Galaxy Overdensity: ALMA + JWST Results and Prospects for the ngVLA

Yoshinobu Fudamoto

Chiba University

Investigating galaxy overdensities is crucial for understanding the early growth of massive (M* > 10^9–10^10 M_sun) galaxies, since dense environments are predicted to accelerate galaxy evolution. Such overdensities have now been reported over a wide redshift range (e.g., z ~ 7–9), but their key properties, such as gas distributions and star-formation efficiencies, remain poorly constrained, making it difficult to assess how environment drives galaxy evolution in the early Universe. Addressing this requires a panchromatic approach, which is now becoming possible through the synergy between JWST and ALMA. We present such an analysis of a massive overdensity at z = 7.88, first identified with JWST (Morishita et al. 2023; Witten et al. 2025). Our ALMA Cycle-10 observations of the [CII] 158 μm line, covering the entire overdensity, reveal a strongly biased gas distribution toward the core, together with complex spatial and velocity structures of neutral gas between merging galaxies at the core. Combined with deep JWST imaging, these data indicate a highly non-uniform neutral gas distribution across the overdensity. Within the gas-rich core, the merger may drive gas stripping, condensation and redistribution, altering the mode of star formation, while the peripheral regions are markedly less gas-rich. Completing this picture requires tracers that probe the neutral interstellar and circumgalactic medium more directly than [CII]. With its sensitivity and resolution, the ngVLA will map low-J CO transitions and dense-gas tracers in such systems, providing unbiased molecular gas masses for individual members of high-redshift overdensities.

Exploring Compact Symmetric Objects in the ngVLA Era

Vasileios Diamantopoulos

Institute of Astrophysics, Foundation for Research and Technology - Hellas (IA-FORTH)

In spite of the century that has passed since Curtis' discovery of the first astrophysical jet in an Active Galactic Nucleus (AGN) in 1918, and seven decades of intensive research of radio and optical jets in AGN, we still do not know their composition (leptonic or hadronic), nor how jets are powered (accretion or spin of the supermassive black hole). We believe that compact symmetric objects (CSOs), studied with the ngVLA, will provide the key to unlocking these mysteries. Very recent results on the CSOs in our VLBA study of a large complete sample - the Extended Very Long Baseline Array total Intensity and Polarization Survey (EVIPS), are casting a fascinating light on these enduring questions, and point to a secure way of answering them with the ngVLA. In this talk we will lay out the plan of attack that both theorists and observers believe will at last answer these questions.

Do Circumnuclear Disks Drive Mass Accretion even in High-Luminosity AGN?

Ryoya Kojima

The University of Tokyo / NAOJ

Izumi et al. (2016) reported a strong correlation between circumnuclear disk (CND) gas mass and AGN accretion rate in low-luminosity AGNs, suggesting that CNDs act as reservoirs supplying gas to central engines. To test whether this picture holds also in higher-luminosity AGNs, we conducted high-resolution (~100 pc) ALMA CO(2–1) observations of 32 nearby high-luminosity AGNs selected from the Swift BAT 70-month catalog, which minimizes selection biases from gas and dust obscuration. We estimated CND gas masses from CO(2–1) luminosities and compared them with accretion rates derived from X-ray luminosities. Contrary to Izumi et al. (2016), we find only a weak correlation between CND gas mass and accretion rate. This discrepancy may be explained by molecular outflows removing gas from the CND region. After excluding galaxies with high Eddington ratios that likely host outflows, we indeed find a stronger correlation. On the other hand, there is always a caveat that CO(2-1) line does not faithfully trace dense molecular gas in CNDs, where local gas densities can exceed its critical density (~10^3-10^4 cm^{-3}). Dense gas observations are therefore required to fully characterize the role of CNDs in mass accretion. In the ngVLA era, spatially resolved (i.e., a few - 10 pc scale resolution) HCN(1–0) observations will become available in the CNDs of nearby AGNs. Combined with three-dimensional kinematic modeling tools such as 3D Barolo, these observations will characterize radial gas distributions and dynamics, allowing us to assess the physical condition of the CNDs (e.g., gravitational stability). We will discuss how the ngVLA will provide transformative, spatially resolved information to study gas accretion from CNDs down to the central AGNs.

Unmasking the circumnuclear radio emission mechanisms in nearby hard X-ray selected AGNs

Andrew Sargent

U.S. Naval Observatory

The Fundamental Reference AGN Monitoring Experiment (FRAMEx) is a research program to the study parsec-scale accretion dynamics surrounding supermassive black holes (SMBHs) in a volume-limited (<40 Mpc) sample of hard X-ray selected active galactic nuclei (AGNs). Despite these AGNs universally exhibiting radio emission in Very Large Array (VLA) imaging, only 13 out of 25 sources in the sample have been detected in the subparsec imaging regime achievable with the Very Long Baseline Array (VLBA). This surprising result indicates that the excess radio emission observed by the VLA but not by the VLBA is produced at physical scales between about 1 and 200 parsecs around the SMBH. In this work, I will present results from an observing campaign to obtain a uniform set of follow-up broadband observations with the VLA where I find that the radio emission is likely too luminous for star formation alone and that AGN winds may be responsible for the extranuclear radio emission exhibited by these objects. I will also discuss how the ngVLA can bridge the gap between the VLA and VLBA observations to help dissect the missing spatial scales.

Unveiling the physical and chemical properties of luminous type 1 AGN NGC 7469: ALMA Results and ngVLA Prospects

Ryo Kishikawa

The University of Tokyo / NAOJ

Active galactic nuclei (AGN) significantly influence galaxy evolution. In the early stages of this evolution, AGN are thought to be deeply embedded in dust and gas. Obscured AGN (N_H ≥ 10^23 cm^-2) are estimated to occupy more than 50% of the total AGN population at least at z < 2. To assess the impact of AGN on the interstellar medium (ISM) of their host galaxies, observations in the (sub-)mm wavelength where dust extinction is minimal are essential, combining (i) spatial resolution sufficient to separate the AGN from the surrounding regions, and (ii) multiple transition line observations, especially high-J transitions of molecular or atomic species tracing warm and dense gas. We present ALMA Band 8 and Band 10 observations including 12CO(7-6), 13CO(4-3), and [CI](2-1) toward the nearby Type 1 luminous Seyfert galaxy NGC 7469 at a spatial scale of 130 pc, detecting significant emission in both the 100 pc scale circumnuclear disk (CND) around the AGN and the surrounding 500 pc scale starburst ring. Combining these data with the existing data of 12CO(1-0), (2-1), (3-2), 13CO(2-1), and [CI](2-1) measured at comparable spatial scales, we performed both LTE (population diagram) and non-LTE (RADEX) analyses. The resulting column density ratios N_C/N_12CO and N_C/N_13CO in the CND region are -2 and ~4 times higher, respectively, than in the starburst ring. This indicates that an X-ray Dominated Region (XDR) driven by the AGN extends over the CND scale, in agreement with previous XDR theoretical models and observations. Using the high resolution and high sensitivity of ngVLA, we would access spatially resolved low-J CO and [CI] transitions of the high-z galaxies (z > 6-7). We discuss the feasibility of such science cases for future AGN studies.

Prospects for Nearby Active Galactic Nucleus Studies with Ultra-High-Resolution Observations

Takuma Izumi

NAOJ

I will present a comprehensive multiwavelength investigation of the Circinus galaxy's nucleus, one of the nearest active galactic nuclei (AGNs), highlighting the physical connection between cold and warm gas, accretion, and feedback. Using high-angular-resolution ALMA observations, we resolve the spatial distribution and kinematics of multiphase gas in the central region. We find that the molecular, atomic, and ionized gas components exhibit distinct dynamical behaviors, together constituting a complex multiphase AGN torus rather than a single coherent structure. Absorption-line observations further reveal dense molecular gas inflowing toward the AGN. The derived physical conditions indicate that gravitational instability in the parsec-scale dense disk plays a key role in driving gas accretion down to the immediate vicinity of the supermassive black hole. I will also report temporal (time) variability of the millimeter continuum emission, revealing a compact flaring event on spatial scales of only ~10 Schwarzschild radii. This flare places a new limit on the magnetic field strength (>100 G) in the immediate environment of the AGN, providing new constraints on the physical conditions of the accretion flow and the innermost torus. By extending these parsec-scale observations to a much larger volume of the nearby Universe, the ngVLA will transform detailed case studies such as the Circinus galaxy into population studies. This will allow us to investigate how the physical properties of the circumnuclear gas, accretion flow, and feedback vary as functions of black hole mass, Eddington ratio, and evolutionary stage, ultimately establishing a unified observational framework for nearby AGNs.

Poster Presentations

Interferometric Image reconstruction using Deep Image Prior neural networks

Joel Sanchez-Bermudez

Instituto de Astronomia - UNAM

We present an interferometric image-reconstruction framework based on deep image prior neural networks for studying the sub-au structure of protoplanetary disks with the Atacama Large Millimeter/submillimeter Array (ALMA) and the next-generation Very Large Array (ngVLA). Unlike supervised learning approaches, the deep image prior does not require a pre-trained model or a library of representative disk images. Instead, the parameters of an untrained convolutional neural network are optimized directly against the measured complex visibilities, while explicitly accounting for the observed u-v coverage. Our algorithm, called ALMA-DIP, provides an implicit image regularization that can suppress poorly constrained artifacts while preserving compact and non-axisymmetric structures. We assess the ability of the method to recover rings, gaps, spirals, and other disk substructures under representative ALMA and ngVLA observing conditions. The reconstructions are compared with conventional CLEAN imaging to check for image fidelity, and robustness. The complementary wavelength coverage and angular resolution of ALMA and the ngVLA make this approach particularly suitable for tracing dust-grain populations, probing disk optical depth, and identifying structures potentially associated with embedded planets.

Measurement Accuracy Requirement of the ngVLA Water Vapor Radiometer system for Atmospheric Phase Correction in Bands 5 & 6

Yoshiharu Asaki

NAOJ

We have conducted a feasibility study on phase correction with 22 GHz Water Vapor Radiometer (WVR) and phase referencing in Bands 5 and 6 of the next-generation Very Large Array (ngVLA). The goal is to clarify the requirements for path length correction accuracy to be delivered by the overall WVR system. In this study, we first estimate the residual path length error with WVR phase correction during the winter season at the ngVLA sites, represented by the VLA site. Next, we derive the requirements for phase correction to satisfy the dynamic range requirements of 32–28 dB in Bands 5–6. We also consider the requirements for interferometric phase stability from the perspective of interferometric coherence. We evaluate the requirements for the WVR system measurement uncertainty, taking into account residual atmospheric phase errors, dynamic range requirements, and interferometric coherence goals. In conclusion, to meet the dynamic range requirements, the accuracy requirement for the WVR path length error estimation at acquisition time intervals of 1−2 s are~160 μm for the 90% coherence goal and ~260 μm for the 80% coherence goal. Finally, we demonstrate the proposed ngVLA phase calibration method through observational simulations. The synthesized CLEAN images prove the excellent performance attainable using a combination of WVR phase correction and phase referencing.

Constraints on au-Scale Structure in the Diffuse Molecular ISM: Multi-Epoch VLBI Absorption and Prospects with the ngVLA

Keisuke Nakashima

Kagoshima University

In the formation of molecular clouds, a scenario has been proposed in which the interstellar medium fragments and condenses, driven by thermal instability, to form tiny-scale structures. The tiny-scale molecular structures (TSMS) on au scales that we probe would be direct observational evidence of such a mechanism. A few are known in emission, but in the low-excitation gas traced by absorption they remain poorly established. Absorption toward a background source probes only a pencil beam through the foreground gas. Since a single observation says nothing of extent, probing TSMS requires either multi-epoch monitoring as gas drifts across the beam, or resolving the background source. Connected-element interferometers have pursued the former, yet few molecular absorption studies have established the existence of TSMS beyond doubt. We therefore turn to VLBI for the latter.

Han et al. (2017) provided the only prior VLBI molecular absorption detection. Extending this work, we detected HCN and HCO+ (J=1-0) toward four background QSOs with the Korean VLBI Network (KVN) at milliarcsecond resolution, and compared absorption depths over time baselines from one year to a decade. No significant variation is found. We discuss limits on column density contrast and, under simple geometric assumptions, on TSMS size.

At present the background sources are unresolved, so the smallest accessible TSMS is limited by array sensitivity. At 3 mm the ngVLA would gain nearly two orders of magnitude over our KVN observations, making smaller structures observable. Moreover, its long baselines would resolve the QSOs, mapping the foreground optical depth across them.

Shocks in classical novae following individual outbursts

Miriam Mumbua Nyamai

Joint Institute for VLBI ERIC (JIVE)

Novae are thermonuclear eruptions that occur on the surfaces of accreting white dwarfs in binary systems. Outbursts in these systems are incredible real-time laboratories for a huge range of astrophysical processes. Shock interactions between different velocity components within the ejected material itself, lead to particle acceleration. The result is the observed GeV γ-ray, highlighting the need to understand the role of shocks in nova eruptions. Our MeerKAT radio observations of V1935 Cen, V462 Lup and V572 Cen following their individual recent outbursts in 2025, reveal evidence of non-thermal emission consistent with particle acceleration in shocks during the first two months of the outburst. This adds to the sample of classical novae that show evidence of non-thermal emission mechanisms observed during this early phase of radio emission evolution.

Exploring Protoplanetary Disk Midplane Heating Mechanisms with Multi-wavelength ALMA and ngVLA Observations

Tian Ahmad Bayuadri

Institute of Science Tokyo

Protoplanetary disks are the birthplace of planets, and their temperature structure plays an important role in disk evolution. Since different heating mechanisms produce different temperature structures, constraining them is important for understanding disk evolution. The classical viscous accretion model typically predicts that the inner (<10 au) disk region is primarily heated by internal accretion heating. However, recent magnetohydrodynamics models suggest that accretion heating is inefficient and the midplane temperature of the inner disk is governed largely by irradiation. Since the inner region is optically thick, observations here often only trace the layers above the midplane; thus constraining the midplane temperature is not straightforward. To constrain and test the efficiency of midplane heating requires wide range multi-wavelengths observations.

In this study, we develop an analytic multi-wavelength radiative transfer framework to predict midplane temperature from observed brightness temperature. Using a given dust temperature, density, and opacity structure, we compute the disk's emergent intensity, convert it to brightness temperature, and compare it against the underlying dust temperature to assess how well each wavelength recovers the temperature structure. Assuming an axisymmetric disk structure, we generated synthetic images from the radial intensity profile. The raw results show that passive and active heating models can be distinguished at longer wavelengths. However, once convolved with ALMA's beam, these differences become harder to differentiate due to the resolution limitations of ALMA's long-wavelength observations. We expect the higher sensitivity and angular resolution of ngVLA could resolve this distinction, providing an observational test of the different heating mechanism models.

Vertical Mixing and Radial Trapping of Pebbles in Protoplanetary Disks

Lizxandra Flores Rivera

University of Tokyo

Dust particles in the outer regions of protoplanetary disks can experience moderate levels of turbulence, which can lift them to the disk surface where their icy mantles are exposed to UV photons, altering the chemical composition of the outer disk. By combining hydrodynamical (gas + dust) simulations with a UV radiation field applied in a post-processing step using RADMC3D, we find that a small fraction (~17%) of 100-micron-sized particles are frequently lofted to a height of Z/R = 0.2. At this altitude, their prolonged residence time enables efficient photodissociation of CO and water, potentially erasing their pristine composition. Additionally, particles undergoing radial and vertical turbulent motions can become concentrated in spontaneously formed vortices and zonal flows, leading to local enhancements in the dust-to-gas mass ratio above solar values. These regions of elevated dust density may have significant implications for dust growth and planetesimal formation. We present new results exploring the observational signatures of such particle-loaded pressure bumps and vortices.

Probing the Subsurface Properties of Solar System Solid Bodies with the ngVLA

Takahiro Iino

University of Yamanashi / The University of Tokyo

Physical properties of the subsurface of planets and small bodies in the Solar System are important for understanding their habitability, evolution, and formation processes. Long-wavelength radio observations, which are sensitive to depths ranging from centimeters to several tens of meters, provide a powerful method for investigating subsurface properties. For example, Redman et al. (1998) demonstrated a diversity of emissivity decreases at longer wavelengths among asteroids using JCMT observations. More recently, Kubota et al. (2025) suggested the presence of a broad, dip-like decrease in emissivity at millimeter wavelengths in the spectral energy distribution (SED) of Charon, Pluto's largest moon. The wide spectral coverage of the ngVLA will enable observations of broadband SEDs for a wide variety of objects, including planetary satellites, asteroids, and trans-Neptunian objects (TNOs). In this presentation, we will discuss the subsurface science of solid bodies that will be enabled by the future capabilities of the ngVLA.

Disk Population Synthesis of structured disks with external photoevaporation

Nicolas Kaufmann

LMU Munich

With the ever-increasing census of protoplanetary disks observed in mm emission, disk population synthesis studies have become an important tool to constrain expected disk properties and the occurrence of sub-structures. Previous studies have revealed that the observed, spectral indices are consistent with ubiquitous substructures emerging at early times. However, it still remains challenging to explain the relation between observed dust and gas radii.

In this work we perform a disk population synthesis study trying to reproduce the observed gas and dust disk radii, the spectral index and the millimetre flux. The substructures are modelled with imposing planetary gaps. We make use of the Tri-PoD dust model for the dust evolution giving us a more accurate dust distribution in structured disks compared to previous population studies. Furthermore, allowing the consideration of additional effects, namely the potential formation of planetesimals via the Streaming instability in the substructures and the consideration of external photoevaporation.

Our results show how the inferred disk properties change considering our improved model. They highlight the effect external photoevaporation has on the disk radii and the continued challenge to match them with observations. This work highlights the importance of accurately modelling the dust distribution in the substructures in the disk and the resulting dust transport passing through them.

Formation Pathways of Inner Rocky Planets Regulated by Midplane Turbulence: Implications for ngVLA Disk Observations

Katsushi Kondo

Nagoya University

Inner planetary systems exhibit striking diversity in mass and orbital architecture, from terrestrial planets in the Solar System to close-in super-Earths. Previous studies have suggested that different pebble supplies can produce these distinct outcomes, but how such pathways emerge from evolving protoplanetary disks remains unclear.

We couple gas, dust, and temperature evolution in disks undergoing magnetically driven wind accretion and weak viscous transport with pebble accretion and Type-I migration of rocky embryos. Our model accounts for dust growth, fragmentation, radial drift, and diffusion, and includes suppression of pebble capture by gas flows around embryos. Pebble fluxes and Stokes numbers are calculated self-consistently from disk evolution.

For fragile dust, we find that midplane turbulence regulates embryo growth and migration through the pebble Stokes number. Stronger turbulence (3×10^-4) produces smaller Stokes numbers (~ 10^-4), suppressing pebble accretion and leaving approximately Mars-mass embryos within the inner disk. Weaker turbulence (3×10^-5) allows larger Stokes numbers (~ 10^-3), enabling embryos to grow to approximately Earth mass and migrate to the disk inner edge. After disk dispersal, subsequent collisions among these embryos may lead to the formation of terrestrial planets and close-in super-Earths, respectively.

Our results identify midplane turbulence as a potential driver of divergent rocky planet formation pathways for fragile dust. Spatially resolved, multiwavelength dust observations with the ngVLA could constrain grain sizes in terrestrial planet-forming regions and, when combined with dust evolution models, help constrain midplane turbulence. Such constraints may help assess which rocky planet formation pathways are favored in different disks.

Evolution of binary fragments in collapsing prestellar cores

Nikita Lileiko

Tohoku University

Binary stars are ubiquitous; they exhibit a range of physical phenomena unique to multiple systems and are a primary target of many modern observational surveys. In particular, recent Gaia observations have provided growing evidence for peculiar features in binary parameter distributions across different mass ranges: the existence of close binaries with separations much smaller than 1 au as well as an overabundance of twin systems with mass ratios near unity. However, the theoretical origin of these features remains unclear.

Since stars form in large-scale collapsing gaseous envelopes and naturally interact with the surrounding environment, it is necessary to study the early evolution of binary seeds embedded in realistic large-scale prestellar cores. To uncover the physical processes governing the evolution of newly formed binaries, we systematically study the growth of these systems by performing three-dimensional numerical simulations. Here, we use a grid-based magnetohydrodynamics framework Athena++ and incorporate gas self-gravity as well as magnetic phenomena.

The results reveal a complex interaction between the binary fragments and the surrounding gas. We find that the orbital evolution of young binaries is driven not only by gas accretion but is also significantly affected by interactions with the massive collapsing gaseous core, leading to orbital decay even in non-magnetized cases. In this presentation, we focus on the physical mechanisms that drive binary migration and discuss what dictates parameter evolution during the early protostellar epoch.

From ALMA to ngVLA: Thermal and Kinematic Structures of Cores in Early-Stage High-Mass Star Formation

Kaho Morii

Center for Astrophysics | Harvard & Smithsonian

Recent ALMA observations have significantly advanced our understanding of the earliest stages of high-mass star formation, revealing complex fragmentation, dense core properties, and chemical signatures within massive clumps. However, two fundamental physical quantities, gas temperature and kinematics, remain poorly constrained at the core scale (<0.05 pc), where the initial conditions for high-mass star and cluster formation are set. Clump-scale (~1 pc) temperatures are often assumed to be uniform, yet core-scale conditions can differ substantially, with direct implications for testing the existence of high-mass prestellar cores. VLA NH3 observations have provided some core-scale temperature constraints, but remain limited: the (1,1) line is often optically thick and self-absorbed at high resolution, tracing extended gas rather than the core itself, while the (2,2)/(3,3) lines, better tracers of dense compact cores, typically lack sufficient sensitivity for robust temperature modeling.

The ngVLA will transform this landscape. Its dramatically improved sensitivity and resolution will enable robust multi-line NH3 mapping to accurately determine core-scale thermal structures, while simultaneously resolving line widths and velocity gradients that trace gas inflow onto forming cores. Building on recent ALMA results, this poster presents the scientific case for using ngVLA to jointly characterize temperature and kinematics in early-stage high-mass star-forming regions, directly constraining formation scenarios.

Conditions and Mechanisms of Dust Concentration under MRI Turbulence

Haruki Nabeta

Tohoku University

The formation of planetesimals, an early stage of planet formation, requires dust accumulation. To understand this process, it is necessary to know how turbulence affects dust accumulation. This study focuses on MRI turbulence driven by magnetic fields, investigating the conditions under which dust can concentrate. We performed MHD local shearing box simulations incorporating ambipolar diffusion. The parameters considered are the Elsaesser number and the Stokes number. The Elsaesser number determines the strength of ambipolar diffusion, which suppresses MRI turbulence. The Stokes number corresponds to the dust size, which determines how strongly dust motion is affected by the gas flow. We confirmed that in environments where turbulence is moderately suppressed by ambipolar diffusion, the gas velocity field generated by magnetic turbulence contributes to the concentration of large dust particles. We have derived the concentration threshold — the point at which the Roche density is exceeded — as an empirical relationship between the Elsaesser number and the Stokes number. In this presentation, we will discuss the physical origin of this condition and the contribution of this mechanism to planetesimal formation. We will also discuss whether this process can be verified using the long-wavelength, high-resolution observations obtained by ngVLA and ALMA.

Cosmic-Ray Ionization Rate in Young Protoplanetary Disks from Particle Tracing Simulations

Erika Nishio

Tohoku University

The ionization degree of gas plays a crucial role in determining magnetic field structures and chemical evolution during the early stages of star and protoplanetary disk formation. Cosmic rays (CRs) are a major ionization source in star-forming regions, particularly during the early phase when other ionization sources are limited by dense gas. Therefore, understanding the spatial distribution of CR ionization rates is essential for clarifying star and disk formation. The CR distribution depends on gas density and magnetic field distribution. Dense gas attenuates CRs through collisions, while higher-energy CRs penetrate more deeply. Magnetic field convergence enhances the CR flux through focusing, whereas magnetic mirroring reduces CR penetration. Quantifying the ionization rate therefore requires treating these effects simultaneously.

We developed a new CR particle-tracing code based on the guiding-center approximation, incorporating scattering by turbulent magnetic fields and energy losses due to gas interactions. Using gas and magnetic field distributions from the early stage of star-disk formation, we calculate CR trajectories and evaluate the effects of focusing, mirroring, and attenuation on the ionization-rate distribution.

Our results show that CRs with energies of several tens of MeV dominate ionization in the envelope and outflow regions, whereas several-hundred-MeV CRs penetrate and ionize the dense disk. Scattering by turbulent magnetic fields enhances magnetic mirroring, reducing the CR density by roughly an order of magnitude in the envelope. These results suggest that the actual ionization rate may be lower than predicted by diffusion-approximation models.

Tracing Gas-Flow towards Protoplanets in Planet-Forming Disks by ngVLA

Hideko Nomura

NAOJ

Compositions of exoplanetary atmospheres and how they are shaped during their formation and evolution stages are the keys to understand the origin of physical and chemical diversity in exoplanetary systems. The ngVLA observations with high spatial resolution at lower frequencies suit well to trace materials flowing into protoplanets in dense regions of planet-forming disks, less affected by obstruction caused by dust opacity. The structures of the flow of gas and dust/ice into protoplanet are not simple, depending on various conditions, such as the planet masses and the thermal condition around the protoplanets. Based on three-dimensional hydrodynamical simulations, taking into account the cooling efficiency, we performed synthetic observations of gas flow into protoplanets. According to the simulations, the gas flow into an embedded protoplanet is not only from the midplane, but the flow from the upper layer plays an important role. The results of the synthetic observations show that CO, 13CO, and C18O J=1-0 lines trace the gas flow in the different (vertical) layer around the protoplanet. Combined with future multi-wavelength observations, observations of gas flow will be useful for understanding compositions of forming protoplanets.

Constraining Inner Disk Structure in Protoplanetary Disks through Shadow Geometry and SED Modeling

Ryuta Orihara

Institute of Science Tokyo

Recent multiwavelength observations have revealed compact inner disks on scales of a few astronomical units in protoplanetary systems. These regions are closely related to rocky planet formation, yet their vertical thickness, radial extent, dust properties, and heating mechanisms remain strongly degenerate when inferred from spatially unresolved spectral energy distributions alone.

High-angular-resolution scattered-light observations provide an additional geometric constraint. Orihara and Momose (2025) showed that shadows cast by an inner disk onto the outer disk can constrain its maximum aspect ratio, defined as the maximum height of the stellar-light-blocking surface divided by its radius. This quantity characterizes the effective obscuring geometry rather than the gas pressure scale height.

We develop a method to search for physical models that satisfy this geometric constraint while simultaneously reproducing the near-infrared emission of the inner disk and its spatially separated submillimeter flux. The density and temperature structures are calculated self-consistently by coupling vertical hydrostatic equilibrium with iterative thermal calculations including stellar irradiation, accretion heating, dust opacity, and dust sublimation. Radiative-transfer calculations are then performed to model the inner-disk emission at near-infrared and submillimeter wavelengths.

We apply this method to HD 100453, adopting the maximum aspect ratio of 0.17 constrained by Orihara and Momose (2025). We identify models that reproduce both observational constraints without requiring strong accretion heating, suggesting that the emission is dominated by a compact dusty disk heated mainly by stellar irradiation. Future high-resolution ngVLA observations will further constrain the dust mass, grain-size distribution, and radial structure of such inner disks.

Turbulence-Regulated Fragmentation and Star Formation Efficiency in CHIMPS2 Molecular Clouds

Raffaele Rani

National Tsing Hua University

Understanding how turbulence shapes molecular-cloud fragmentation and regulates star formation remains a central problem in Galactic star formation studies. Using the CO Heterodyne Inner Milky Way Plane Survey 2 (CHIMPS2), we combine a uniform catalogue of 5242 molecular clouds identified in 13CO(3-2) emission with 17,328 associated substructures (dendrogram leaves).

For each cloud, we derive the fractions of turbulent power in solenoidal and compressive motions and compare them with the physical and evolutionary properties of the embedded leaves. Combining CHIMPS2 with the Herschel infrared Galactic Plane Survey, we estimate star formation efficiencies for both clouds and leaves and characterise the evolutionary state of the dense structures.

We investigate how fragmentation and star formation vary with turbulent mode balance and Galactic environment. Star formation is strongly concentrated within dendrogram leaves, supporting their identification as the actively star-forming component of molecular clouds. Although the number of leaves per cloud depends only weakly on Galactic environment and on the balance between solenoidal and compressive turbulent modes, more solenoidal clouds tend to fragment into a larger number of dense substructures, whereas more compressive clouds preferentially host fewer but more massive structures. Leaf virial parameters decrease systematically with leaf mass, consistent with a scenario in which compressive motions promote the formation of more gravitationally bound structures with higher star formation efficiencies. Together, these results suggest that turbulence influences how molecular-cloud mass is partitioned among dense structures, with implications for their fragmentation and gravitational state.

Tracking massive star feedback and its impact on molecular cloud dissipation using NH_3

Yosuke Shibata

Nagoya University

Massive stars affect and disperse their natal molecular clouds through radiative and mechanical feedback. However, how the disruptive feedback from massive star propagates by heating up the molecular gas remains poorly understood. We investigate temperature distributions and identify dense warm regions to study how UV radiation from massive stars propagates outward from the interior of a dense core.

We constructed rotational-temperature (Trot) maps from NH_3 (J,K) = (1,1) and (2,2) emission by the Green Bank Telescope ($\Delta\theta$ = 32") toward 29 star-forming regions and found that Trot correlates well with the mid-infrared luminosity. It distinguishes quiescent, infrared-dark dense gas at ~10 K from actively star-forming clouds at 30–40 K. Radial temperature profiles around 19 heating sources indicate that warm dense gas is localized within 3 pc. To investigate how UV radiation propagates over these scales, the Trot is compared with the beam-diluted excitation temperature Tex. From the significant underestimation of Tex, the beam-filling factors of the dense NH3 gas is derived to be below unity and anti-correlated with Trot. This suggests that there are unresolved substructures in the heated environments, that let the UV less shield in dense gas. In Orion A, comparison with ALMA observations ($\Delta\theta$ = 4.5") reveals a positive correlation between the NH_3 beam filling factor and the 0.05 pc scale substructures in N_2H^+ called fibers, confirming that the beam filling factor traces small-scale gas structure.

Future high-resolution, high-sensitivity NH_3 observations with the ngVLA will directly reveal this feedback-driven evolution across diverse Galactic environments to much farther molecular clouds.

Resolved Structure and Orbital Motion of a Localized 1 au-scale Dust Accumulation in the Protoplanetary Disk around TW Hya

Takashi Tsukagoshi

Ashikaga University

We present ~1au-resolution ALMA observations of the TW Hya protoplanetary disk in the Band 6 dust continuum and the 13CO and C18O J=2-1 emission lines, focusing on the kinematics, internal morphology, and gas environment of the prominent dust blob at a radius of 52au. By comparing our 2021 data with 2017 archival observations, we detect the proper motion of the blob. The measured azimuthal velocity of 3.3±0.9km/s is fully consistent with local Keplerian rotation. Combined with the lack of significant radial migration, this confirms that the structure is robustly co-moving with the disk.

Crucially, our high-resolution continuum map resolves the blob into a distinct double-peaked morphology separated by ~1.7au azimuthally, which we robustly validate in the independent 2017 dataset using sparse-modeling image reconstruction. We discuss potential physical origins for this double-peaked morphology, including an inclined circumplanetary disk with an inner dust cavity, the roots of planet-induced spiral arms, or alternative hydrodynamic scenarios without an actively accreting planet such as the U-turn trajectory of secondary dust or a short-lived hydrodynamic gas vortex.

Even after combining short-baseline archival data to recover extended flux, we detect no compact gas emission counterparts associated with the continuum blob. Since these CO lines likely trace optically thick upper atmospheric layers, the absence of localized vertical gas perturbations suggests that if an embedded planet is responsible for the dust structure, its mass must be exceptionally low.

Observational structures created by a jumping planet

Kim Melanie Weiskopf

LMU Munich

Dust structures in protoplanetary discs are commonly observed, yet their origin remains an open question. While planets are among the leading explanations, the common assumption that each observed gap requires a separate planet deserves to be revisited. This talk explores the role of a single migrating planet undergoing intermittent episodes of rapid migration, known as migration jumps. Importantly, these migration jumps arise self-consistently from the planet–disc interaction rather than being imposed artificially in the model. During these jumps, the planet leaves behind its previously carved gap and opens a new one at its updated location, naturally producing multiple gaps in the disc. The resulting dust distribution is strikingly similar to the substructures observed in the DSHARP survey. A key finding is that these structures are strongly shaped by the disc's cooling properties. I will therefore highlight why cooling is essential for realistic models, their interpretation and deductions for observations. Finally, I will discuss whether, and how, future observations with the ngVLA could help determine how many planets are actually required to explain the observed disc structures.

Protoplanetary Disk with the SKA

Yinhao Wu

NAOJ/EACOA

The Square Kilometre Array (SKA) will open a new observational window on protoplanetary disks by combining unprecedented sensitivity and angular resolution at centimetre wavelengths. In this talk, I will discuss how future SKA observations can address several fundamental questions in planet formation. Continuum observations will directly probe centimetre-sized pebbles, reveal dust structures hidden by high optical depths at millimetre wavelengths, and test whether rings, gaps, spirals, and asymmetries are produced by embedded planets, dust trapping, or other disk processes. Large surveys of nearby star-forming regions will further establish the demographics and evolutionary pathways of pebbles, while providing improved constraints on disk dust masses and the material available for planet formation. Spectral-line observations will probe the chemistry of the disk midplane and inner regions that are obscured to ALMA, potentially detecting complex organic and carbon-bearing molecules whose strongest low-energy transitions lie at centimetre wavelengths. Meanwhile, spatially resolved free–free emission and hydrogen recombination lines will offer new diagnostics of ionized gas, accretion, jets, and magnetically or photoevaporatively driven disk winds.

Outlook for ngVLA Observations of Dust Grains in V883

Rui Zhuang

The University of Tokyo

Grain growth in protoplanetary disks is considered as the onset of planet formation. The water-snow line, defined as the sublimation front of water ice within disks, is believed to play a crucial role in facilitating the coagulation of ice-covered grains suggested by theories. V883 Ori experiences a FU Orionis-type outburst, during which its bolometric luminosity exceeds 200 times that of the Sun. The outburst pushes the water-snow line beyond 40 au from the central star, making it an ideal candidate for investigating grains in water-ice free regions. Using Atacama Large Millimeter/submillimeter Array (ALMA) observations in Band 3, 4, 6, and 7 with a spatial resolution of 0.08”, we investigate the distributions of grain sizes in V883 Ori by multi-band analysis. The results indicate the presence of centimeter-sized grains in the outer disk. However, the grain sizes within 40 au remain less well constrained, with two possible solutions: one in the submillimeter regime and the other above the centimeter regime. This degeneracy likely results from the continuum emission not being optically thin even in ALMA Band 3. To constrain grain sizes in these inner regions, lower frequency observations are desired. The ngVLA is expected to provide lower frequency observations while offering higher angular resolution, allowing constraints on the grain sizes in inner, hot disk regions of V883 Ori and test the extent to which grain growth can proceed in the absence of water ice, further extending this investigation to other young stellar objects during quiescent phases.

Accretion outbursts and substructure at the dead zone inner edge

Alexandros Ziampras

LMU Munich

Accretion outbursts in young stellar objects are believed to be caused by a sudden increase in the mass accretion rate from the protoplanetary disk onto the central star, with significant implications for both disk evolution and planet formation. We present state-of-the-art radiation hydrodynamical simulations of accretion outbursts driven near the inner edge of the dead zone, incorporating, for the first time, a self-consistent treatment of dust growth and dynamic/radiative coupling between gas and dust. Our models showcase the significance of dust evolution in regulating the thermal structure of the disk, and the role of emerging vortices in determining the overall dynamics and planetesimal formation efficiency. We then present mock observations with ngVLA, showing that it will be possible to spatially resolve outburst-driven substructure at sub-au scales.

Probing 3D magnetic fields in star-forming regions: Insights from dust polariation and Zeeman observations

Jihye Hwang

Kyushu University

Magnetic fields play a crucial role in the dynamics of star-forming regions by regulating gravitational collapse. To quantitatively assess the importance of magnetic fields on star formation compared to gravity and turbulence, accurate measurements of magnetic field strengths are essential. However, observational techniques are typically limited to detecting either the plane-of-sky component from dust polarization or the line-of-sight component from the Zeeman effect. By combining these two orthogonal measurements, it becomes possible to estimate the full three-dimensional (3D) magnetic field strength. In this presentation, we will present an analysis of the correlation between CN line emission and dust continuum emission in six high-mass star-forming regions. From the archival observations of dust polarization and CN Zeeman measurements, we estimate 3D magnetic field strengths and compare them with gravity toward the star-forming regions. These findings offer a pathway toward comprehensive 3D magnetic field studies in star-forming regions, particularly with the enhanced capabilities of a upcoming observational facility of ngVLA.

Modeling Nitrogen Isotope Fractionation of Ammonia in Protoplanetary Disks: Implications for ngVLA Observations

Ryota Ichimura

RIKEN

NH3 is a key nitrogen carrier for tracing the chemical evolution of volatile nitrogen during star and planet formation, and its inversion transitions are promising targets for future ngVLA observations. We performed disk chemical model calculations to investigate how nitrogen isotope fractionation produced in the disk gas layer is transferred to NH3 ice reservoirs outside the NH3 snowline. The model includes isotope-selective photodissociation of N2, nitrogen isotope-exchange reactions, gas-grain chemistry, turbulent vertical mixing of gas, and dust-size-dependent settling and ice chemistry. Our calculations predict that NH3 ice is not radially uniform in its nitrogen isotopic composition: strong 15N enrichment appears around 100 au, while other radii retain ratios closer to the elemental value. These results motivate spatially resolved observations of NH3 gas with the ngVLA. In disk gas, isotope-selective photodissociation of N2 can produce 15N-poor NH3, leading to high 14N/15N ratios. If NH3 gas is additionally supplied by non-thermal desorption or release from icy grains, 15N-enriched NH3 ice could lower the observed gas-phase 14N/15N ratio, even if the gas remains overall 15N-poor. A localized decrease in the NH3 gas 14N/15N ratio around 100 au would suggest that 15N-enriched ammonia ice is concentrated in that region, whereas a broader decrease would imply a more widely distributed ammonia reservoir, possibly through inheritance or redistribution of icy solids. Comparing ngVLA NH3 observations with ALMA measurements of HCN and CN isotopologues would test how nitrogen fractionation in the disk gas layer is connected to ammonia-bearing icy material.

Unraveling Water and Complex Organic Chemistry within the Water Snowline: Importance of ngVLA Observations

Shota Notsu

The University of Tokyo

Revealing complex organic chemistry in planet-forming disks is a key to understand the origin of chemical complexity and habitability in planetary systems. We report the results of our recent ALMA observations of Complex organic molecules (COMs) in Band 3 and Band 1, and Band 7 water for the disk around the FU Ori type protostar V883 Ori (Yamato, Notsu et al. 2024, 2026; Nakasone, Notsu et al. 2026). We found from the Band 3 observations that the COMs abundance ratios wrt CH3OH are significantly higher than those in the warm Class 0 protostellar envelopes of IRAS 16293-2422 and similar to the ratios in the comet 67P, suggesting the efficient (re-)formation of COMs in disks. The 12C/13C ratios of COMs are consistently lower (~20-30) than the canonical ratio in the ISM (~69), indicating the efficient 13C-fractionation of CO. From our ALMA Band 1 observations (Yamato, Notsu et al. 2026, arXiv:2607.12005), we derived the radial intensity profile of the CH3OH emission where we found a steep increase within 40 au. The column density of CH3OH reaches at least ~10^19 - 10^20 cm^-2 at ~10 au (at T~300 K). This provides direct evidence that a significant amount of warm gaseous methanol is present in the innermost region of the disk where its emission has been suppressed in previous (sub-)mm observations due to the optically thick dust emission. Our results demonstrate the capability and significance of (sub-)cm observations in probing the innermost opaque region of disks, paving the way for the future ngVLA observations.

Multi Molecular Line Observations to Reveal Physics and Chemistry in Disk/Planetary-System Forming Regions of Protostellar Sources

Yoko Oya

Kyoto University

To understand the origin of the Solar system, the physical/chemical evolution along the star/planet formation is a key issue. Extensive observational studies have recently revealed that both the physical structure and the chemical composition drastically change during the disk formation around protostars. Furthermore, it has been found that molecular distributions are sensitive to changes in the physical conditions. Some kinds of molecular lines are therefore prospected to work as ‘molecular markers’ to selectively highlight particular structures of disk-forming regions.

Conversely, detailed physical characterization is essential for elucidating the chemical evolution occurring there. It has recently been recognized that some molecular lines tend to trace the mid-plane of a disk/envelope system and others trace its surface. The traced kinematic structure may differ among these molecular emissions, and thus, their careful analyses are essential for further observational studies in disk-forming regions. Machine learnings may help us to disentangle the observed structures.

Specifically, sulfur-bearing species have empirically been good tracers for disk/envelope/outflow structures in low-mass YSOs. Their emissions at mm wavelength are useful to characterize the angular momentum of the gas, which is the essential topic to understand the structure formation. Such a chemical diagnostics at cm wavelength is thus worth establishing to investigate structures at the scale for planetary formation and outflow-launching point, and also in high-mass counterparts; moreover, it can be realized with various large/complex organic molecules. ngVLA is an ideal equipment for this purpose, which will progress our understandings for structure formation and material evolution simultaneously by supporting each other.

Expansion of young HII regions as a driver of non-metastable ammonia masers

Yaoting Yan

NAOJ

Ammonia masers are rarer in our Galaxy than water, OH, and methanol masers. In this talk, I will present new results on non-metastable ammonia masers from our JVLA A-configuration observations toward two peculiar high-mass star-forming regions and discuss the pumping scenarios.

Dust Seeding Molecules in a Massive Protostar -- Detection of TiO in Orion Source I

Ziwei Zhang

RIKEN

We report the first detection of TiO in star-forming regions based on Atacama Large Millimeter/submillimeter Array observations of Orion Source I, a well-characterized massive protostar. Multiple rotational transitions are identified, with emission spatially resolved within ~ 50 au, showing a compact distribution with a velocity structure consistent with the base of a rotating outflow. The spatial and velocity distributions of TiO are consistent with those of AlO, with both species being key dust seeding refractory molecules. The column density of TiO is derived to be $(1.7 \pm 0.2)\times10^{15}\ {\rm cm^{-2}}$, corresponding to $X_{\rm TiO/SiO} \sim 7.2 \pm 0.9 \times10^{-3}$, comparable to CI chondrites and indicative of efficient dust-to-gas conversion near the protostar. We also identify a tentative detection of AlOH, which exhibits a more extended distribution along the disk surface, \textbf{possibly} indicating different conditions from those traced by TiO and AlO. The detection of TiO, a key dust seeding species, offers important constraints on refractory chemistry and the formation environments of primitive minerals, linking astrochemical processes in protostellar systems to the earliest stages of Solar System material formation.

Absorption Spectroscopy of Diffuse gas in the Outer Galaxy with the ngVLA

Michael Busch

NRAO

The cold fraction of atomic interstellar gas is remarkably constant with Galactocentric radius out to ~20-40 kpc (Dickey et al. 2009, 2022). This cold neutral medium is exactly where we expect molecule formation to occur (McClure-Griffiths et al. 2023). However, the molecular fraction is far more uncertain beyond the solar circle, because CO becomes a less reliable proxy for H_2 (e.g. Pineda et al. 2013, Busch et al. 2021). Sensitive absorption measurements of H I and molecular tracers against compact background sources can measure both the CNM fraction and the molecular fraction. The ngVLA is the first instrument capable of doing this at matched optical depth across a wide range of important diffuse molecular gas tracers. A VLASS+NOEMA/ALMA calibrator cross-check yielded 89 outer-Galaxy sightlines producing H I, OH, CH, HCO^+, and CO absorption for the first time using the same telescope. A sensitivity model cross-checked against the ngECT yields optical depth sensitivities of ~1e-3 for the median source in the catalog, with sources that have nearly flat SEDs from H I 21 cm to HCO^+. Three tunings target all these tracers in ~450 hours. The ~2000 compact cm-bright VLASS sightlines extend OH and CH to a legacy sample. These measure the CO-dark gas fraction and X(CO) against the Galactic metallicity gradient, the OH, HCO^+, and CH abundances against one another, and the scale height of diffuse molecular gas with Rgal.

What Powers the Multiwavelength Emission from Embedded Super Star Clusters in M82?

Maria Jesus Jimenez Donaire

AURA for ESA (STScI)

Super star clusters (SSCs) represent an extreme mode of star formation and may provide nearby analogs of the environments in which massive bound clusters formed at earlier cosmic epochs. However, the physical nature of SSCs during their earliest, deeply embedded stages remains poorly understood. M82, the nearest northern starburst galaxy, offers a unique laboratory for resolving these systems on parsec scales.

I will present a high-resolution Submillimeter Array study of M82's central starburst, combining 350 GHz continuum imaging with dense-gas tracers including HCN(4–3), HCO+(4–3), and H13CN(4–3). Systematic compact-source identification provides a census of over 50 candidate embedded SSCs and measurements of their natal dense-gas environments. Comparisons with HST and JWST cluster catalogs reveal several SMA-selected sources without detected optical or infrared counterparts, potentially identifying a highly obscured and younger population inaccessible at shorter wavelengths.

Preliminary radio-to-submillimeter measurements reveal substantial source-to-source diversity, but the available 6, 22, and 350 GHz measurements cannot uniquely determine the relative contributions of synchrotron, free-free, and dust emission, or establish the physical nature of the sources lacking shorter-wavelength counterparts. The ngVLA will address this limitation through sensitive, matched-resolution broadband continuum measurements across the centimeter-to-millimeter spectrum. Combined with radio recombination lines, dense-gas measurements, and optical and infrared counterparts, these observations will clarify the nature of individual compact sources and test how their properties relate to massive-cluster formation and emergence.

Imaging of SiO masers in Galactic Center with VERA using new dual-beam phase referencing technique

Kaito Kawakami

Kagoshima University

At the center of the Milky Way Galaxy (MW) lies the Nuclear Stellar Disk (NSD), a structure with a radius of approximately 200 pc and a thickness of about 50 pc. There is evidence suggesting that the NSD formed as a result of explosive star formation triggered by gas inflow into the central region during the formation of the Milky Way's bar structure. This star formation is believed to have propagated in a ring-like pattern; as a result, stars younger than 500 Myr still appear to form a ring-like distribution without straying far from their points of origin. To characterize this spatial structure, it is desirable to measure the proper motions of stars obtained through high-resolution observations using VLBI (Very Long Baseline Interferometry). In this presentation, we will introduce astrometric measurements of circumstellar maser sources associated with long-period variable stars (LPVs) distributed within the NSD, using VERA (VLBI Exploration of Radio Astrometry). Since the target is a weak maser source and has a low elevation angle as viewed from Japan, we performed dual-polarization and wideband dual-beam astrometry with higher sensitivity than in previous studies. We discuss the maser sources that were successfully imaged as a result. We also outline how this research will "evolve" with the ngVLA.

Caterpillar in a Cabbage: The Origin of a Massive HI Reservoir around an Optically Faint Galaxy

Jeein Kim

Yonsei University

We report the discovery of an atomic hydrogen (HI) gas reservoir, spatially coincident with the optically faint galaxy LEDA 136976. Follow-up Gemini-N/GMOS spectroscopy reveals Hα, [O III], and [N II] emission, confirming that the HI gas is physically associated with the target, and both the HI and Hα kinematics trace coherent rotation. Our target's HI reservoir is comparable in size and mass to local spirals like the Milky Way and M31, while its stellar mass remains below 10% of the Milky Way's. We investigate whether the galaxy's optically faint appearance reflects a genuinely low-mass, gas-rich system caught in an early, gas-accreting phase of star formation, or a more massive star-forming disk galaxy whose optical light is heavily suppressed by foreground dust extinction. We present observational constraints, including dust-corrected colors, stellar mass, and metallicity, and place the system on known scaling relations such as the Tully-Fisher relation. We discuss the implications either interpretation holds for the census of gas-selected local galaxies currently missed by HI and optical surveys.

High-redshift radio AGNs from wide-area surveys: HSC–VLASS results and ngVLA prospects

Youwen Kong

The University of Tokyo

Large radio continuum surveys are valuable resources for searching for radio active galactic nuclei (AGNs). Combined with deep optical surveys, they allow us to construct samples across a wide range of redshifts toward the epoch of reionization. In this study, we present the high-redshift radio AGN search from the WERGS project. Using optical identification of VLASS radio sources with Subaru/HSC-SSP over ~1,200 deg2, we select 352 radio AGN candidates through g/r/i/z-dropout techniques, targeting z~4–7. By further combining measurements from FIRST, LoTSS, and TGSS, we construct radio spectral energy distributions (SEDs) spanning MHz to GHz frequencies without imposing radio spectral-index preselection. This approach reveals a diverse population with predominantly flat to moderately steep spectra, including a subset with turnover spectra. These turnover spectra are consistent with synchrotron self-absorption or free-free absorption and may be associated with compact, young, or environmentally confined radio jets. We also examine the candidate number density and find a declining trend toward higher redshift, although its interpretation remains subject to selection effects and redshift uncertainties. Our study provides a basis for follow-up observations to investigate the emergence and evolution of radio-jet activity in the early Universe. We briefly discuss prospects for next-generation radio facilities, particularly the ngVLA, to resolve radio structures and investigate interactions between jets and their host galaxies.

Revealing evolutionary stage of HI Monsters using resolved HI kinematics with JVLA

Kibeop Lee

Yonsei University

Galaxies evolve as they form stars through replenishing their cold gas reservoirs via multiple gas accretion pathways. HI-rich galaxies have been extensively studied to understand the details of gas accretion and the triggering of subsequent star formation, which are still not properly established. The question of whether the gas-rich nature has an external origin is also controversial. In this regime, we investigate a subsample of 'HI Monsters', which are 10 massive late-type galaxies that are rich in both HI and CO. We obtain interferometric HI data with the JVLA, from which we derive resolved HI kinematics using forward modeling technique. We perform gravitational stability analysis using our models to estimate whether this massive HI reservoir is stably rotating. We also examine dart matter halo properties through Bayesian approach and connect them with the HI richness of the sample. From our results, we argue that the large HI reservoirs of our targets are not due to intrinsic properties of dark matter halo but rather caused by recent accretion event. Part of the accreted gas could have been transformed into more denser gas phase, enhancing the molecular gas content. Constraining gas accretion scenario requires more in-depth observations, for which ngVLA could play an important role.

Probing Feedback at High-Redshift with ngVLA using Sunyaev-Zeldovich Effect

Kyle Massingill

NRAO

The Sunyaev-Zeldovich effect (SZE) is a powerful probe into high-redshift Active Galactic Nuclei (AGN) feedback. The energy injected into the circumgalactic medium (CGM) by thermal winds from the AGN is directly proportional to the magnitude of the observed thermal SZE, which has a redshift independent surface brightness. Despite these advantages, sensitivity has been a key obstacle to studying feedback in this way as the thermal energy from an individual galaxy is far less than that of massive clusters, which have been studied extensively with SZE. Feedback in the redshift range of z~2-3 is a key part of the story of galaxy evolution as we seek to better understand the processes regulating the growth of galaxies on long timescales. The ngVLA therefore represents a significant opportunity to move the study of galaxy evolution forward with its order of magnitude improvement to sensitivity over the current VLA and goal of ~90% observing efficiency. We present our work setting limits on the thermal SZE signal around high-redshift galaxies using ALMA band 4 and GBT Mustang-2. We project how ngVLA will improve access to the SZE signal around distant galaxies and what targets we would propose when the instrument is complete.

Molecular Gas Structure and Star Formation Diversity in Stephan's Quintet

Kazuyuki Muraoka

Osaka Metropolitan University

We present 12CO(1-0) mapping across the entire system of Stephan's Quintet observed by Atacama Compact Array. These observations provide the first large-scale (137 kpc × 119 kpc), spatially resolved (~5.5 kpc) molecular gas map of a compact group. Our CO map revealed that most of the molecular gas resides in the disk of the member galaxy NGC 7319 and in the intergalactic regions, including components along the shocked filament and the optically identified tidal tail extending from NGC 7319. Along the tidal tail and its surroundings, we found not only an extended molecular gas component but also four discrete CO clumps, with velocity dispersions of ~10-30 km/s and molecular gas masses of order 10^7-10^8 solar masses. Three of these clumps spatially overlap with HI, whereas the remaining clump shows no associated HI or counterparts at optical and infrared wavelengths. Using star formation rates derived from Hα luminosities of HII regions, we found that star formation efficiencies (SFEs) span ~2.2 dex (~0.02-4 /Gyr) and negatively correlate with CO velocity dispersion. While regions with small velocity dispersion exhibit SFEs comparable to those of nearby disk galaxies, those with large velocity dispersion (~50-150 km/s) around the shocked filament show strongly suppressed star formation. These results suggest that turbulence plays a significant role in regulating star formation in interacting systems. We also plan to discuss the prospects for ngVLA observations of interacting galaxies.

Dissecting the Heart of Starburst Galaxies by ngVLA High-resolution Observations

Kouichiro Nakanishi

NAOJ

Nearby nuclear starburst galaxies are hosting pc-scale clumps which are rich in interstellar matter, specifically warm/hot dense molecular gas and dense ionized gas. The clumps are hosting up to hundreds massive young stars, and they are supposed to be the birthplace of massive stellar clusters.

ngVLA is expected to provide close-up views of the gas clumps than ever before by its superb high angular resolution accompanied with high surface brightness sensitivity. Observation of radio recombination lines (RRLs) is of particular interest. It is one of the most powerful measures to go deep into the clumps to see how massive stars are aborning inside their natal dense interstellar matter. ngVLA high angular resolution (10 milliarcseconds) observations of RRLs will be able to reveal the internal structure of the pc-scale clumps, in other words 'dissect' them, and those data could help us to estimate the properties of ionized gas with minimum assumptions.

The poster will provide a feasibility study of ngVLA high angular resolution observations of RRLs toward nearby starburst galaxies and discuss their science goals.

Accretion Dynamics of Hot Halo Gas Driven by Thermal Instability Fueling the Galactic Star Formation

Izumi Seno

Nagoya University

Gas accretion from the Galactic halo is essential to sustain the quasi-steady-state evolution of the Galactic disk and its long-term star formation. Recent multi-wavelength observations have revealed the multiphase structure of the Galactic halo, including massive halo gas and high-velocity HI clouds. Focusing on the metal-polluted hot halo gas, we investigate thermal instability as a key mechanism driving this accretion onto the disk. We perform 2D hydrodynamic simulations incorporating radiative cooling, thermal conduction, and gravitational acceleration. Our results demonstrate that the mass accretion rate reaches several solar masses per year, which sufficiently exceeds the current star formation rate. Thus, thermal instability of the halo gas may be crucial to fuel ongoing star formation in the Milky Way. We will also derive a theoretical formula to interpret the numerically derived mass accretion rate. Additionally, our presentation will highlight the crucial role of the next-generation Very Large Array (ngVLA) in observing the diffuse HI component, which dominates the overall mass accretion process.

Galaxy Interaction–Induced Star Formation in Nearby Galaxies

Kengo Tachihara

Nagoya University

Galaxy collisions are widely thought to trigger bursts of star formation. However, close gravitational encounters between galaxies can also induce internal disturbances and gas accretion, thereby promoting active star formation even without a direct collision. Recent observations of atomic and molecular gas, together with measurements of the proper motions of young stars, are beginning to reveal these processes in increasing detail.

The Magellanic Cloud system is a well-known example of interacting galaxies. One proposed scenario is that the infall of H I gas from the Small Magellanic Cloud (SMC) toward the Large Magellanic Cloud (LMC) has triggered active star formation, including the formation of the massive stellar cluster in 30 Doradus. The distribution of the low-velocity H I component in the LMC revealed by ATCA+Parkes observations, together with proper-motion studies of massive stars using Gaia, suggests that large-scale induced star formation has occurred continuously as a result of the interaction.

We have also analyzed recent observations of M33 obtained by the JVLA as part of the Local Group L-Band Survey and identified H I components whose velocities deviate from the regular galactic rotation by several tens to ~100 km s^{-1}. These components appear to consist of high- and intermediate-velocity clouds with a total mass of $\sim10^8,M_\odot$. Their infall may provide fresh fuel for star formation in M33 and contribute to sustaining its active star-forming activity.

Cosmic Magnetism in Galaxy Clusters in the Era of SKAO and ngVLA

Takuya Akahori

NAOJ

The intracluster medium (ICM) in galaxy clusters is expected to be magnetized and turbulent. But the origin and nature of the magnetic field is poorly understood, remaining its true impact into cosmology and the structure formation theory open. Recent astronomical telescopes such as XRISM in X-rays and SKA Pathfinders and Precursors in long-wavelength radio have been focusing on solving these problems. In my presentation, I briefly recap a theory of magnetic turbulence and reconnection, then introduce our previous works, which bring new insights into magnetic turbulence and reconnection in galaxy clusters. We discuss future prospects toward SKAO and ngVLA.

Phase-Recurrent Coherent Radio Pulses From Polars

Walter Golay

Center for Astrophysics | Harvard & Smithsonian

Polars are cataclysmic variables with strongly magnetized white dwarfs accreting from a Roche-lobe-filling companion via a magnetically confined accretion stream. Although radio emission has been detected from more than 30 systems, orbital-phase-resolved radio properties have remained poorly characterized. Here we report highly circularly polarized periodic radio pulses from 9 of 11 polars observed at multiple epochs with the Karl G. Jansky Very Large Array at 8--12 GHz, reminiscent of the budding class of long-period radio transients (LPTs). The pulses consistently occur near the secondary star's superior conjunction and persist for at least days to months. Pulse detections from systems across a wide range of orbital inclinations indicate a fan-shaped emission beam: narrow within the orbital plane but extended perpendicular to it. The two undetected systems are eclipsing, where radiation originating from the secondary cannot propagate past the white dwarf's strong magnetosphere. Simultaneous optical observations show no statistically significant correlation between optical and radio pulse flux densities, indicating that the radio bursts are decoupled from the accretion stream. These characteristics are consistent with electron cyclotron maser emission from magnetic loop structures oriented parallel to the orbital plane and located near the line of centers point on the secondary star.

Probing the Engines and Environments of Superluminous Supernovae with the ngVLA

Bunyo Hatsukade

NAOJ

Superluminous supernovae (SLSNe) are rare stellar explosions whose peak luminosities exceed those of ordinary supernovae by factors of 10-100, yet their progenitors and powering mechanisms remain uncertain. Radio observations provide a dust-independent view of both the explosions and their host galaxies, probing synchrotron emission from ejecta or jets interacting with circumstellar material, compact central engines, and obscured star formation.

Our VLA studies have demonstrated the potential of this approach. Deep 3 GHz observations revealed previously hidden star formation in several SLSN host galaxies. Long-term monitoring of the SLSN-I PTF10hgi further revealed significant late-time radio variability, with a light curve peaking approximately 8-9 years after explosion. Its origin remains consistent with scenarios including a magnetar-powered wind nebula, while distinguishing such emission from weak AGN activity and other alternatives requires substantially improved sensitivity and spectral coverage.

The ngVLA will transform these studies by extending sensitive radio monitoring to much larger samples and to substantially fainter emission over longer timescales. Broad frequency coverage and repeated observations will measure radio spectra and temporal evolution, constrain magnetar nebulae, off-axis jets, and ejecta-circumstellar-medium interactions, and provide sensitive measurements of obscured star formation in SLSN hosts. Such systematic observations will establish the diversity of late-time radio behavior and provide new constraints on the physical origin of these extreme stellar explosions.