Poster Presentation Abstracts

P1

Erica Behrens (Ohio State University)

Scott Ransom (The National Radio Astronomy Observatory)
Dustin Madison (West Virginia University)

Topic: Planetary Systems

Searching for Planets Around Millisecond Pulsars

We search for extrasolar planets around millisecond pulsars (MSPs) using pulsar timing data and seek to determine the minimum detectable planetary masses as a function of orbital period. Using the 11-year data release from the North American Nanohertz Observatory for Gravitational Waves (NANOGrav), we look for variations from our models of pulse arrival times due to the presence of exoplanets. No planets were detected around the MSPs in the NANOGrav 11-year data set, but taking into consideration the noise levels specific to each pulsar as well as the sampling rate of our observations, we develop limits that suggest we are sensitive to planetary masses as low as those of the moon and even large asteroids.

P2

Sabrina Berger (McGill University)

Casey Law (University of California, Berkeley)

Topic: Formation and Evolution of Compact Objects

Characterizing the Sensitivity of *realfast* at the Very Large Array to Fast Radio Bursts

realfast is a real-time commensal Fast Radio Burst (FRB) instrument on the Very Large Array (VLA) telescope in Socorro, New Mexico. FRBs are powerful millisecond radio bursts of extragalactic origin. By discovering more FRBs, we can better understand their origins and how they enable us to probe the universe. The VLA is an ideal instrument for studying FRBs because it can localize and detect faint radio transients. The CHIME FRB rate is expected to be between 2 to 50 FRBs per day, and the VLA is an ideal instrument for follow up analysis of these detections. The *realfast* pipeline uses millisecond visibility data to dedisperse and generate 100 million images per hour. We use simulated data to test the FRB search pipeline and characterize its sensitivity and completeness. We vary mock transient parameters such as dispersion measure, galactic coordinates, and SNR and inject these simulated transients into the pipeline. We hope to validate the pipeline is working as expected and constrain a limit on the rate of FRB detections given system sensitivities to ensure thousands of hours of successful commensal observing at the VLA.

P3

Diana Blanco (California State University, Northridge)

Topic: Star and Planet Formation

Imaging Substructures in Protoplanetary Disks with the ngVLA

Protoplanetary disks, planar, rotating structures composed of gas and dust, are a natural byproduct of stellar formation. Over the span of a few million years, the collisional assembly of dust grains (mm/cm sized particles) in disks surrounding young stars are thought to condense into planetesimals (km sized). Numerous physical processes have been suggested to explain the evolution of protoplanetary disks. However, several observational limitations arise due to the insufficient sensitivity and resolution of current telescopes. The Next Generation Very Large Array (ngVLA), thanks to its unprecedented sensitivity and angular resolution would allow us to detect, for the first time, structures in the disk predicted by physical processes which are thought to be responsible for the formation of planetesimals, the building blocks of planets. In this poster, I will present new results derived from ngVLA simulations using disk models that capture some of these physical processes.

P4

Natalie Butterfield (Green Bank Observatory)

Ashley Barnes University of Bonn
Mattia Sormani University of Heidelberg

Topic: Star and Planet Formation

Investigating the Star Forming Potential of the Galactic Bar

The dust lanes in our Galactic Bar are thought to mediate the flow of material from the Galactic Disk towards the Galactic Center, fueling the extreme environment found within the Central Molecular Zone region. The study of these dust lanes features is, therefore, critical for our understanding of the mass, energy and chemical evolution and transport across the Galaxy. In my talk I will discuss a scientific opportunity in the dust lane features of the Galactic Bar. I will further highlight how potential observations can assess the star-forming potential of the gas within the dust lanes, and thereby test current Galactic dynamics and star formation theories.

P6

Carlos Carrasco-González (Instituto de Radioastronomía y Astrofísica, IRyA-UNAM)

Topic: Star and Planet Formation

Observing Planet Formation with the VLA in the Era of ALMA

In only four years, ALMA has radically changed the field of planet formation. We are currently obtaining very detailed images of the dust emission in protoplanetary disks with an unprecedent sensitivity and high angular resolution. The most important result up to now is that almost all protoplanetary disk we have observed show substructures in the dust distribution in the form of high density rings and gaps. These structures were expected in the case of already formed planets, but their commonness is making us to think that dense rings are indeed the regions where dust can accumulate to start to form new planets. However, the study of the dust properties in these rings is becoming extremely difficult even with ALMA. Due to their high density, they remain very optically thick at millimeter wavelengths, and observations at longer wavelengths are necessary to obtain dust physical properties. Then, ironically, ALMA has revealed the VLA as a fundamental instrument to study planet formation. In this talk, I will present an analysis of all the available high angular resolution millimeter data on the iconic protoplanetary disk HL Tau. The inclusion in the analysis of high quality VLA images at long wavelengths allow to study the dust properties distribution with a resolution of only 7.5 au. This is a fundamental step in order to understand how, when and where the dust in protoplanetary disks form protoplanets.

P8

Dongwoo Chung (Stanford University)

[co-authors TBD]

Topic: Galaxy Evolution

Revealing the Galaxy-Halo Connection Through CO Line Searches with ngVLA

Low-J CO line emission is an important probe of molecular, star-forming gas. The COLDz survey (PI: Riechers) has resulted in the best constraints on the CO luminosity function at z ~ 2-3 to date. I will discuss the implications of these constraints for the galaxy–halo connection. I present a simple double-power-law model relating halo mass to CO luminosity, effectively connecting the molecular gas contents of a galaxy to its host halo's mass. The basic form is well-motivated by existing empirical modelling and measurements of relations between halo mass, star-formation rate, IR luminosity, and CO luminosity. I show that a knee of some kind in the L(M) relation is favoured but the COLDz constraints only completely bound the mass and luminosity scale of the knee of this relation, and only result in one-sided bounds for the power-law slopes. I will then briefly consider how the significantly enhanced capabilities of the ngVLA will enable greater constraints on the galaxy–halo connection, and how possible synergies with dedicated line-intensity mapping surveys could further enhance these constraints.

P9

Daniel A. Dale (University of Wyoming)

Jordan A. Turner (University of Wyoming)

Topic: Galaxy Evolution

An ALMA-HST Study of Cold Dust Emission and Star Clusters in NGC628

We present an update on our joint ALMA-HST study of the nearby galaxy NGC628. A comprehensive database for 1000+ star clusters from the HST LEGUS survey is combined with recent ALMA observations of the cold dust continuum in NGC628. The 20 pc resolution of the ALMA maps allows for a detailed analysis of the spatial variations in the slope of the cold dust emission with the ages and masses of the nearby star clusters. We find evidence for an excess of dust emission at millimeter/sub-millimeter wavelengths, but little dependence on the slope of this emission with stellar cluster age or mass.

P10

Christian Davila-Peralta (The University of Arizona)

Justin Hyatt (The University of Arizona)

Topic: Other

Results on Induction Thermoforming Manufacturing Technology for Antenna Panels Fabrication

Results on a novel manufacturing technology developed at the Steward Observatory are reported below. Induction slumping methods offer significant advantages compared to current methods in terms of speed, energy, and flexibility. Different shapes can be achieved with low RMSE suitable to produce antenna panels. Recently, panels have been produced at the Steward Observatory Solar Lab with desired results. Several aluminum alloy blanks (image 1), 125 mm in length/width and 3 mm in thickness were shaped in a glass-mica machined mold. This mold had a spherical concave face on its top and square sides, with a curvature radius of 1.4 m (figure 1, figure 2). Measuring with a coordinate measuring machine (CMM), the mold had an RMS Error of 75 um against a paraxial parabola with equivalent focal length. The aluminum piece was slumped in approximately 20 minutes using ~1 kWh of total energy. The results showed a 45 um RMS error against a paraxial parabola with a 744.71 mm focal length (equivalent to 1.48 m radius sphere). The difference in focal length was accounted for with the spring back phenomena known to occur in hot stamping processes. Current research involves characterizing and predicting spring back to potentially prescript a mold shape that compensates for this phenomenon.

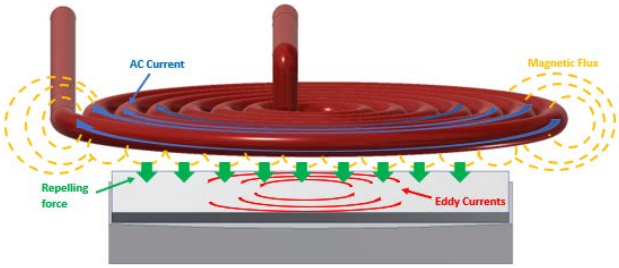


Figure 2. Experiment diagram using a pancake coil, under which a aluminum panel sits on top of a rotating mold.

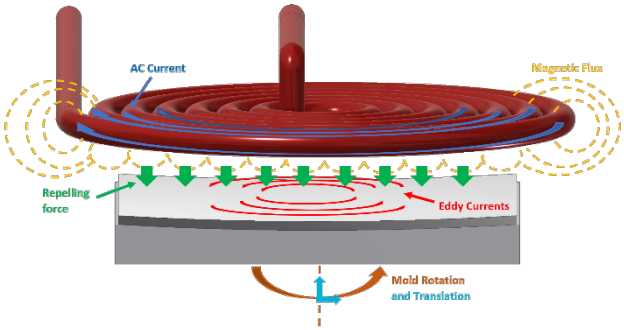


Figure 1. Experiment diagram with the aluminum plate taking the shape of the mold.

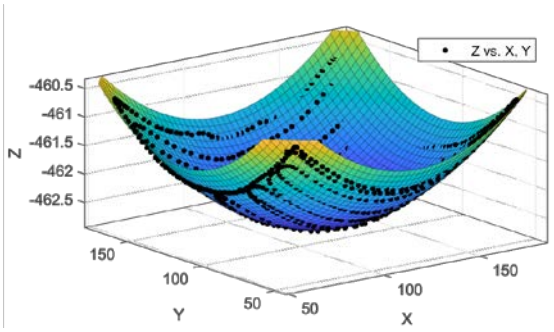


Figure 4. Curve fitting for the CMM data of the aluminum panel showing an RMS error of 45 um, and a focal length of XX.

Figure 3. Slumped aluminum test plate example, having a lower focal length to show curvature.

P11

Samer El-Abd (University of Virginia)

Crystal Brogan (National Radio Astronomy Observatory)
Todd Hunter (National Radio Astronomy Observatory)
Eric Willis (University of Virginia)
Robin Garrod (University of Virginia)
Brett McGuire (National Radio Astronomy Observatory)

Topic: Star and Planet Formation

Interstellar Glycolaldehyde, Methyl Formate, and Acetic Acid: Bi-Modal Abundance Patterns in Star-Forming Regions

The photo-dissociation of methanol (CH3OH) in the interstellar medium is still not a particularly well-understood phenomenon. Since many of the radicals that are formed from this process go on to form the $C_2H_4O_2$ isomers glycolaldehyde, methyl formate, and acetic acid, measuring the relative abundances of these molecules can give us clues as to the rates at which the radicals are produced. Data on the relative abundances of these molecules also has the potential to constrain formation pathways for the molecules that are necessary for life to emerge. For this analysis we derived molecular abundances of the isomers in two massive cores of NGC 6334I using ALMA spectroscopic data, then examined the literature to find every source for which at least two of the isomers had measured column densities. This resulted in 15 total sources among which we could compare relative abundances of the $C_2H_4O_2$ isomers.

P12

Maxwell Hummel (Rice University)

Andrea Isella (Rice University)

Topic: Star and Planet Formation

Dense Cores in the Chaotic Carina Nebula

We recently used ALMA to image a PDR in the Carina Nebula, hoping to observe young, pre-stellar objects in a more energetic environment that we can more readily observe in our immediate neighborhood. We observed several dense, starless cores in a 1' by 1' region of a molecular cloud near the very luminous cluster Trumpler 14, a few of which are Jeans unstable. However, ALMA lacks the angular resolution and sensitivity to probe the structure of these cores. With the NGVLA we will be able to image the individual cores in greater detail, likely observing evidence of collapse and infalling material. With the improved sensitivity and higher wavelength, we will also likely find more cores deeper into the cloud.

P13

Justin Hyatt (The University of Arizona)

Christian Davila (The University of Arizona)

Topic: Other

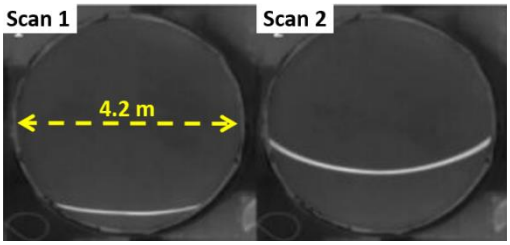
A Rapid and Adaptable Method for Manufacturing High-Accuracy Antenna Reflectors

We have developed a new fabrication process for antenna reflector panels. The thermoforming method uses induction to rapidly and efficiently heat a flat sheet of aluminum to high temperature. The sheet is them pressed into an adjustable mold. The shape of the mold can be tuned to different prescriptions to make different segments of an off-axis dish or to make panels for different dish designs. The speed and agility of the process enable low non-recurring engineering (NRE) costs, short turnaround time, iterative testing, and a project-driven delivery schedule. A similar process was used to make a 13 m diameter off-axis antenna using glass panels. We also present a metrology system that uses infrared deflectometry for rapid verification of panel surface accuracy.

A glass antenna reflector made by thermoforming

A thermoformed aluminum panel

An computer-controlled adjustable mold



IR deflectometry scan image during the grinding of 4.2 m DKIST mirror.

P14

Eric Faustino Jiménez-Andrade (University of Bonn)

Benjamin Magnelli (University of Bonn), Alexander Karim (University of Bonn), Gianni Zamorani (INAF), Marco Bondi (INAF), Eva Schinnerer (MPIA), Mark Sargent (University of Sussex), Emilio Romano-Díaz (University of Bonn), Mladen Novak (MPIA), Phillip Lang (MPIA), Frank Bertoldi (University of Bonn), Eleni Vardoulaki (University of Bonn), Sune Toft (DAWN), Vernesa Smolčić (University of Zagreb), Kevin Harrington (University of Bonn), Sarah Leslie (MPIA), Jacinta Delhaize (University of Cape Town), Daizhong Liu (MPIA), Chris Karoumpis (University of Bonn), Jeyhan Kartaltepe (Rochester Institute of Technology) and Anton Koekemoer (STSI)

Topic: Galaxy Evolution

Radio Continuum Size Evolution of Star-Forming Galaxies Over $0.35 < z < 2.25$

To better constrain the physical mechanisms driving star formation, we present the first systematic study of the radio continuum size evolution of star-forming galaxies (SFGs) over the redshift range $0.35 < z < 2.25$. We use the VLA COSMOS 3GHz map (noise rms=2.3μJybeam^{-1}, θ_{beam} =0.75arcsec) to construct a mass-complete sample of 3184 radio-selected SFGs that reside on and above the main-sequence (MS) of SFGs. We constrain the overall extent of star formation activity in galaxies by applying a 2D-Gaussian model to their radio continuum emission. Extensive Monte Carlo simulations are used to validate the robustness of our measurements and characterize the selection function. We find no clear dependence between the radio size and stellar mass, $M_\star$, of SFGs with $10.5<\log(M_\star/M_\odot)<11.5$. Our analysis suggests that MS galaxies are preferentially extended, while SFGs above the MS are always compact. The median effective radius of SFGs on (above) the MS of $R_{eff} = 1.5 \pm 0.2$ (1.0 ± 0.2) kpc remains nearly constant with cosmic time a parametrization of the form $R_{eff} \propto (1 + z)^{\alpha}$ yields a shallow slope of only $\alpha = -0.26 \pm 0.08$ (0.12 ± 0.14) for SFGs on (above) the MS. The size of the stellar component of galaxies is larger than that inferred from radio continuum emission by a factor ~2 (1.3) at $z = 0.5$ (2), indicating star formation is enhanced at small radii. The galactic-averaged star formation rate surface density (Σ_{SFR}) scales with the distance to the MS, except for a fraction of MS galaxies (10%) that harbor starburst-like Σ_{SFR}. These "hidden" starbursts might have experienced a compaction phase due to disk instability and/or merger-driven burst of star formation, which may or may not significantly offset a galaxy from the MS. We thus propose to jointly use Σ_{SFR} and distance to the MS to better identify the galaxy population undergoing a starbursting phase.

P15

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Matthew Kerr (Naval Research Laboratory)

Topic: MMA

Commensal Sub-GHz Science from within the ngVLA Infrastructure: Lessons from VLITE

Motivated by the Astro 2020 Decadal Survey scientific white papers we review the science potential of a sub-GHz commensal system embedded within the ngVLA infrastructure. Our technical inspiration comes from the VLA Low Band Ionosphere and Transient Experiment (VLITE: http://vlite.nrao.edu), currently running on the VLA and recording over 6000 hours per year. With its naturally large field-of-view it has observed more than 80 percent of the sky for at least 10 minutes, while other fields have been observed for hundreds of hours. The cost for VLITE, to date, has been approximately 1/2 of 1 percent of the capital investment in the VLA. Its fully automated science ready data pipeline was developed by a handful of people over a few years.

Many impactful radio astronomical discoveries have been serendipitous, including the microwave background, pulsars, fast radio bursts and radio astronomy itself. Commensal observing is an efficient path to serendipitous discovery, and a sub-GHz system embedded within the vast infrastructure of ngVLA will require minimal resources to implement. We review scientific applications falling under two generic themes. One is as a radio-LSST, carrying out a continuous synoptic survey of large swaths of sky for both slow and fast transients, including coherent emission from NS-NS mergers, PSRs, FRBs, and predicted but undiscovered source classes. A second is through complementary low frequency images of all ngVLA targets, offering a powerful leverage arm in frequency space for constraining radio emission mechanisms in both Galactic (e.g. SNRs, PWNs) and extragalactic (e.g. AGN, clusters) sources. Unique insights from coincident lower frequency data include inferring the relative radial superposition of nonthermal and thermal components, and leveraging propagation effects as probes of the intervening ionized medium to cosmological distances. We use VLITE as a guide for imagining how a sub-GHz commensal system on the ngVLA can enhance its scientific productivity.

P16

Amanda Kepley (National Radio Astronomy Observatory)

Topic: Galaxy Evolution

Dense Extragalactic GBT+Argus Survey (DEGAS): A Case Study for Radio Cameras on Large Single Dishes as ngVLA Precursors

A key science goal for the ngVLA is to study the evolution of galaxies throughout cosmic time. One of the primary drivers for this evolution is the transformation of dense molecular gas into stars and the subsequent destruction of the gas by the newly formed stars. Observations of the dense molecular gas and stars in nearby galaxies are crucial for understanding the star formation process because they can be observed at astrophysically interesting resolutions (<1kpc) without the geometric uncertainties inherent in Milky Way observations. Here we use DEGAS — Dense Extragalactic GBT+Argus Survey — to demonstrate how radio/submm cameras (focal plane arrays or phased array feeds) on large single dish telescopes can make progress in the area leading up to the ngVLA. DEGAS is a GBT Large Program mapping four dense molecular gas tracers (^{13}CO(1-0), C^{18}O(1-0), HCN(1-0), HCO+(1-0)) in the central 2’ by 2’ of 36 nearby galaxies using a 16 pixel focal plan array (Argus). When complete, this survey will be the largest resolved survey of dense molecular gas tracers in nearby galaxies to date. These observations will allow us to quantify both the fraction of dense gas and the relationship between that dense gas and star formation in a wide variety of environments. The results from these moderate resolution (10”) observations will guide future ngVLA observations at higher resolution (1”) incorporating more molecular gas tracers. Argus represents the tip of the iceburg for array size — even larger arrays (~100 pixels) could be built today allowing even faster survey speeds.

P17

Shuo Kong (Yale University)

Héctor G. Arce (Yale), Jesse R. Feddersen (Yale), John Carpenter (JAO), Fumitaka Nakamura (NAOJ), Anneila Sargent (Caltech), John Bally (CU Boulder), Paola Caselli (MPE), María José Maureira (Yale; MPE), Andrea Isella (Rice), et al.

Topic: Star and Planet Formation

Interferometric Mosaics of Molecular Clouds

We present mosaic images of three giant molecular clouds using CARMA and ALMA. The molecular line images show the overall picture of the clouds and set the ground for follow-up studies of filament and star formation. Complex gas structures are revealed in the Orion A cloud and the North American Nebula. A survey of CO outflows in IRDC G28.37+0.07 indicates a picture of filament-feeding star formation. Previous NH3 surveys by GBT and VLA greatly help with the interpretation of the physical properties. The next-generation VLA will bring the study of molecular clouds and star formation to another level.

P18

Sean T. Linden (University of Virginia)

Aaron Evans (University of Virginia), Eric Murphy (NRAO), Yiqing Song (University of Virginia), Lee Armus (California Institute of Technology), Jason Surace (California Institute of Technology), Dillon Dong (California Institute of Technology) Emmanuel Momjian (NRAO), Loreto Barcos-Munoz (NRAO), Kirsten Larson (California Institute of Technology), Robert Kennicutt (University of Arizona)

Topic: Galaxy Evolution

Understanding the Radio Continuum Properties of Star-Forming regions in both Normal and Extreme Environments in the Local Universe

To date, several nearby galaxy surveys such as the Spitzer Infrared Nearby Galaxies Survey (SINGS), the Key Insights on Nearby Galaxies: A Far-Infrared Survey with Herschel (KINGFISH), and the Great Observatories All-Sky LIRG Survey (GOALS), have produced a large number of diagnostic tools used to characterize star formation activity (e.g., UV, H-recombination lines, dust emission, 20 cm radio continuum, [CII]). However, a key piece of data that is lacking from such studies is a systematic measurement of the current (< 10 Myr) and massive SFR for a large range of galactic environments. Nearly all massive stars form deep within molecular clouds, where only a small fraction of the photospheric UV radiation escapes over the first few million years. As a result, long-wavelengths that penetrate dust are critical for studying the earliest phases of star formation and allow us to properly interpret other diagnostics, which are sensitive to metallicity, dust extinction, gas content, and a range of timescales.

Radio continuum observations have proven to be a workhorse in our understanding of the star formation process (i.e., stellar birth and death) from galaxies in the nearby Universe. This emission is unaffected by extinction and can be related directly to ionizing photon production by newly-formed massive stars. Here, we present results from two large Jansky Very Large Array (VLA) 33 GHz, 15 GHz, and 3 GHz imaging campaigns of star-forming regions in 50 normal star-forming galaxies, taken from the SINGS/KINGFISH legacy survey as part of the Star Formation in Radio Survey (SFRS), and 68 luminous infrared galaxies taken as part of GOALS. We have measured flux densities, spectral indices, star-formation rates (SFRs), and ages for nearly 400 individual star-forming regions across a combined galaxy sample which spans nearly 4 decades in stellar and molecular gas mass. Overall, we find that *extranuclear* regions identified in our LIRG survey have radio spectral indices and thermal fractions consistent with *circumnuclear* star-forming regions found in the SFRS, and that on 10-100 pc scales radio emission from individual star-forming regions in both normal and extreme galaxies is dominated (> 90%) by free-free emission. Further, we observe a significant increase in the scatter of the measured spectral index and thermal fraction distributions as a function of galactocentric radius. This trend is reflective of the ongoing star-formation activity occurring in the centers normal galaxies, and results in an excess of diffuse nonthermal emission. Finally, when we place all regions on the star-forming main sequence of galaxies (SFMS), defined here by the SFRS galaxy sample, we find that star-forming regions in LIRGs are not consistent with their host galaxies' globally averaged specific star-formation rates, and have a considerably shallower SFR-M_* slope.

What is ultimately required to make large strides in this field are robust maps of star formation activity for large (> 100), diverse, samples of nearby galaxies. With an order of magnitude improvement over current facilities, a next-generation Very Large Array (ngVLA) could deliver maps of the massive SFR in galaxies to the same depth as currently-available Halpha observations (i.e., an rms of ~0.1 uJy/bm) nearly 100x faster than the current VLA, making such large surveys feasible for the first time. Finally, by coupling free-free continuum maps with near-/mid-infrared H-recombination line maps (e.g., from JWST-MIRI), we can estimate the electron temperature, and thus the metallicity of the ionized gas across entire galaxies. This is a crucial ingredient needed for understanding the complex phase transitions of the ISM, and the recycling of material into stars and back as galaxies evolve.

P19

Jason Ling (Rice University)

Andrea Isella (Rice University), Christopher Johns-Krull (Rice University), Joseph Lazio (JPL/Caltech)

Topic: Low-Frequency Radio, Exoplanets, Young Stars

Characterizing the Low-Frequency Radio Environment in Nearby Stellar Systems

Detections of low-frequency (< 10 GHz) radio emissions can help characterize the radiation environments around nearby stellar systems. Planetary origins of the emission, produced primarily through charged particles radiating via the electron cyclotron maser [ECM] instability, correlate directly with the local magnetic field strength of the emitting body. Recent radio detections of active brown dwarfs have begun to constrain the observational and magnetic properties of extrasolar, near planetary-mass emitters of ECM. Additional non-detections of lower-mass objects of interest continue to refine the upper limits on the typical emission from exoplanetary systems. On the other hand, stellar radio emission in our Solar System is enhanced during episodic flaring events and coronal mass ejections, which contribute to the notion of space weather. Stellar radiation environments, as well as exoplanetary magnetic fields, would play important roles in the ongoing question of planetary habitability.

In our study, we analyze a variety of sample populations of interest using data from 3 low-frequency radio sky surveys to look for evidence of stellar and/or planetary emissions. We utilize archival data from the 74 MHz VLA Low-frequency Sky Survey redux [VLSSr], the 150 MHz TIFR GMRT Sky Survey [TGSS], and the 1.4 GHz NRAO VLA Sky Survey [NVSS] to look at the positions of exoplanetary systems within 300 parsecs, young stellar objects in the Taurus and Upper Sco star-forming regions, and stars within a few tens of parsecs in distance from the Earth. We investigated direct, positional detections as well as stacked averages of the imaged data, deriving their statistical significance relative to their respective sky survey. Over 70 tentative direct detections were made, which will require follow-up observations, and we also present upper limits on the emission fluxes from the ensemble-averaged samples for each surveyed frequency for consideration by the community. We interpret these results in the context of current and future instrumental capabilities, such as the ngVLA, in order to provide a basis for future detection efforts.

P20

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F. Durret (Institut d'Astrophysique de Paris. Paris, Fr.)

Topic: Galaxy Evolution

Transformation of Spiral Galaxies in Clusters: Study of Atomic Hydrogen in Abell 496

This work is devoted to the study of the evolution of galaxies in nearby clusters and, in particular, to the transformation of spirals into earlier morphological types. With this aim we used HI images of the Abell cluster A496 (z=0.033), as well as deep optical (ugri-bands) images taken with the 3.6m CFHT. The HI data was taken with the NRAO-VLA; these images trace the distribution of the inter-stellar medium in spirals galaxies, and enable the study of ram-pressure stripping (RPS) exerted by the intra-cluster medium. In total we detected 58 galaxies in HI. We studied the distribution of the HI rich (and poor) spirals throughout the whole cluster, as well as the distribution of perturbed and non-perturbed galaxies, as seen in the optical images. Combining both techniques we are able to unveil those regions of the cluster which are more affected by RPS and those zones dominated by strong tidal interactions. We present as well preliminary results on the degree of dynamical evolution of this cluster.

P21

Thomas J. Maccarone (Texas Tech University)

Anthony Gonzalez (University of Florida)

Topic: Multi-messenger Astronomy and Astrophysics

LISA Standard Sirens, ngVLA Proper Motions, and 6D Phase Space Measurements of Galaxy Clusters

Gaia has revolutionized our ability to understand Galactic structure by providing precise distances and proper motions for large numbers of stars. For understanding the structures of galaxy clusters, the combination of LISA and ngVLA will open up the possibility to make the same kinds of analysis, at least for a few galaxies in the nearest clusters. Stellar mass black hole binaries will provide standard siren distances for some galaxies in Virgo, while ngVLA proper motions will be possible for nearly all galaxies with even low luminosity AGN. I will discuss this possibility as well as some other uses of proper motions of galaxies in groups and clusters.

Emily Moravec (University of Florida)

Anthony Gonzalez (University of Florida), Daniel Stern (JPL), Tracy Clarke (Naval Research Laboratory), Mark Brodwin (University of Missouri), Bandon Decker (University of Missouri), Peter R. Eisenhardt (JPL), Wenli Mo (University of Florida), Alexandra Pope (University of Massachusetts), Spencer A. Stanford (University of California – Davis), Dominika Wylezalek (European Southern Observatory)

Topic: Galaxy Evolution

Radio-Active CoWS: Probing the Role of Environment on Radio-AGN in Massive Galaxy Clusters at z~1

AGN properties and dense environments are connected in a myriad of ways. For galaxies, the hot gas found in dense environments can impact AGN fueling and confine AGN outflows. Meanwhile, feedback from AGN jets can have a significant mechanical and thermal impact upon the surrounding gas. To better understand the interplay between AGN and the hot intracluster medium (ICM) in galaxy clusters, we have been investigating the distribution of AGN and properties of the AGN population associated with z~1 galaxy clusters from the Massive and Distant Clusters of WISE Survey (MaDCoWS). We present the results from a study with the Karl G. Jansky Very Large Array (JVLA) to determine the radio morphologies of extended radio sources and the properties of their host-galaxies in a sub-sample of ~50 MaDCoWS clusters. These clusters are drawn from a cross-correlation of MaDCoWS clusters with the VLA Faint Images of the Radio Sky at Twenty-Centimeters survey to identify extended radio sources within 1′ of the cluster centers. Out of the 52 targeted sources, 29 are FR II sources, 4 are FR I sources, 4 are bent-tail sources, and 13 have undetermined morphologies. We investigate the role of environmental factors on the radio-loud AGN population. We find no significant correlations between the AGN luminosity or host galaxy stellar mass and environmental properties, indicating that these AGN properties are insensitive to the large-scale environment. The only exception is that the highest stellar mass hosts are confined to the cluster center. We do see tentative evidence for an increase in the size of the jets with cluster-centric radius, which can be understood as arising due to the decreased ICM pressure confinement with increasing radius.

P22

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Chiara Mazzucchelli (European Southern Observatory, Santiago de Chile)
Chris Carilli (National Radio Astronomy Observatory, Socorro, New Mexico, USA)

Topic: Galaxy Evolution

Interstellar Medium in the Early Universe: A Multi-Line ALMA Survey of a Redshift 7.5 Quasar

Observations of high redshift galaxies represent the frontier that pushes our understanding of the early universe. In this endeavor quasars can be of great assistance due to their extremely large luminosities powered by supermassive black hole accretion and their non-transient nature. I will present new ALMA observations of quasar J1342+0928 at redshift of 7.5, which currently holds the record as the most distant quasar detected. We have conducted a multi-line survey of this galaxy targeting multiple atomic fine structure lines and molecular lines in the far infrared regime. Such a line survey allows us to probe in detail the properties of the interstellar medium of the host galaxy such its density, radiation field, ionization state and gas mass, when the universe was only 0.7 Gyr old. Given continuum detections across multiple ALMA bands we can now provide much tighter constraints on the dust mass of the host galaxy. We also have secure detections of [CII] 158um, [NII] 122um, and [OIII] 88um lines, yielding unprecedented amounts of information at these early cosmic epochs. This study demonstrates the power of the current mm interferometers and gives a preview of the possibilities that will open with the next generation facilities such as the ngVLA.

P23

Alice Pasetto (Instituto de Radioastronomía y Astrofísica, IRyA-UNAM)

Omaira González-Martín (IRyA-UNAM)
Donaji Esparza-Arredondo (IRyA-UNAM)
Natalia Osorio-Clavijo (IRyA-UNAM)
César Ivan Victoria-Ceballos (IRyA-UNAM)
Mariela Martínez-Paredes (Korea Astronomy and Space Science Institute)

Topic: Multi-Messenger Astronomy and Astrophysics (MMA)

On the Detectability of the Dusty Torus in the (Sub)mm Wavelength

This talk will focus on a very interesting topic nowadays such as the detectability of the emission associated with the Active Galactic Nuclei (AGN) dusty structure at (sub)mm wavelengths. We hack this issue with a theoretical and observational approach. Theoretically, we investigate this subject using the Clumpy model together with the fundamental plane scaling relations. The latter was included since a no negligible contribution at (sub)mm wavelength may still come from AGN radio jets. For the observational approach, we used four prototypical AGN: NGC 1052, NGC 1068, NGC 3516, and IZw1, with cm (JVLA A-configuration), (sub)millimeter (ALMA), and mid-IR (Spitzer) available data. After performing the mid-IR and cm-spectrum fitting separately, we combined and extrapolated both fits to the (sub)mm window. Our observational results are consistent with our theoretical results for which the most accreting source, the QSO IZw1, is our suitable candidate for the detectability of the torus. From our study we strongly recommend that multi-wavelength observations, including high angular resolution centimeter data, is mandatory for the detectability of a torus at the (sub)mm window. This will be a very important subject to be addressed to the upcoming ngVLA facility. Indeed, preliminary estimates on the detectability and possible imaging of the dusty torus with ngVLA will also be shown in this talk.

P24

Pallavi Patil (University of Virginia)

Kristina Nyland (NRL), Mark Whittle (UVa), Mark Lacy (NRAO), Carol Lonsdale (NRAO)

Topic: Galaxy Evolution

Young Radio AGN in the ngVLA era

Most massive galaxies are now thought to go through an Active Galactic Nucleus (AGN) phase one or more times. Yet, the cause of triggering and the variations in the intrinsic and observed properties of the AGN population are still poorly understood. Young, compact radio sources associated with accreting supermassive black holes (SMBHs) represent an essential phase in the life cycles of jetted AGN for understanding AGN triggering and duty cycles. The superb sensitivity and resolution of the ngVLA, coupled with broad frequency coverage, will provide exciting new insights into our understanding of the life cycles of radio AGN and their impact on galaxy evolution. The high spatial resolution of the ngVLA will enable resolved mapping of young radio AGN on sub-kiloparsec scales over a wide range of redshifts. With broad continuum coverage from 1 to 116 GHz, the ngVLA will excel at estimating ages of sources as old as 30-40 Myr at z ~ 1. In combination with lower frequency (< 1 GHz) instruments such as ngLOBO and the Square Kilometer Array, the ngVLA will robustly characterize the spectral energy distributions of young radio AGN. In this talk, we present radio SED modeling of a sample of young radio AGN selected by cross-matching WISE and NVSS catalogs. Our sample galaxies are believed to be in a unique evolutionary stage just after the (re)ignition of the radio AGN, while the host galaxy is still experiencing substantial starburst activity. We discuss the crucial role of ngVLA in studying the radio properties and the jet-ISM feedback in such young, z ~2 AGN populations.

P25

Leonid Petrov (NASA GSFC)

Topic: Simulation of ngVLA performance

The Use of NASA Numerical Weather Models for Evaluation of Atmospheric Opacity at ngVLA Sites

The output of numerical weather models provide the 4D field of the state of the atmosphere. This field can be used for computation of the path delay in the atmosphere, opacity, and atmosphere brightness temperature. I have computed atmospheric opacity and brightness temperature for all planned ngVLA sites at a number of frequencies for one year. I present typical opacities and atmosphere brightness temperatures for all the ngVLA sites for different seasons.

P26

Nickalas Reynolds (The University of Oklahoma)

John Tobin (NRAO)

Topics: Star and Planet Formation

Dynamics and Formation Mechanisms of Protomultiple, L1448 IRS3B

ALMA Cycle 4 (Band 7; ∼870 microns) observations of the nearby (d∼230 pc) triple protostar system, L1448 IRS3B, have resolved continuum spiral structure originating from an inner (∼80 AU) protostellar binary with a third companion embedded (∼230 AU) within one of the arms. Current observations and efforts have yet to fully characterize the kinematics of this multiple system, which is needed to confirm if gravitational instability (GI) of the disk formed the multiple system.

The continuum spiral structure does not directly shed light on the disk kinematics but the molecular line emission provides a complementary view. We use the molecule $C^{17}O$ (J=3-2) to trace the warm (> 15K), dense gas of the IRS3B disk, uncovering information regarding the kinematics therein. Simple PV analysis shows the protomultiple disk is consistent with Keplerian rotation about a central mass of 1.1 $M_{\odot}$ and the dust continuum is consistent with a disk mass of ∼700 M_J.

We model the $C^{17}O$ visibilities using a radiative transfer code (RADMC-3D) in tandem with a Markov-Chain Monte-Carlo program (MCMC; emcee) to better constrain the protostellar parameters and examine the disk kinematics. Furthermore, we use similar methodologies to constrain the mass of the disk using the dust continuum.

We further discuss the implications of our results with the formation of stellar multiples and theorize the mechanisms of GI formation in this archetypal system.

P27

Lerato Sebokolodi[123]

Rick Perley[3], Chris Carilli[3], Jean Eilek[34], Oleg Smirnov[12]

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Topic: Galaxy Evolution

Cygnus A: New Insights into Radio-Galaxy Physics with the JVLA

Our new wideband (2-18 GHz), high spectral resolution polarization study of Cygnus A radio galaxy with the JVLA reveals significant depolarization below 6 GHz at a resolution of 0.75" (750 pc), as well as complicated depolarization structures. The newly measured rotation measures (RM) are consistent with those obtained from previous studies; with RMs going up to 6000 rad/m². The data also indicate that the majority of these large RMs originate from a medium external to the lobes, supporting earlier work. Our study of the depolarization, on the other hand, shows that the majority of the depolarization and structures are a result of unresolved small-scale (< 300 pc) fluctuations in the magnetic field or electron density distributions, or both. However, it still remains a mystery whether these complex magnetic fields (and/or electron densities) reside in ambient cluster gas, or inside the radio lobes or within the shocked IGM gas surrounding the lobes. In order to address this problem, we need higher resolution (< 0.3 arcseconds) observations with high sensitivities to resolve the small-scale structures responsible for the depolarization. The planned maximum baseline of the ngVLA of ~300 km makes it an ideal instrument for detailed polarimetry of extragalactic sources. We present current data and our ongoing analysis.

P28

Evan Sheldahl (National Radio Astronomy Observatory)

Eric Murphy (National Radio Astronomy Observatory)

Topic: Galaxy Evolution

Studying the Cosmic Star Formation History with Deep, Multi-Configuration 10 GHz VLA Observations of the GOODS-N Field

We present early results of high angular resolution 10 GHz observations of the Great Observatories Origins Deep Survey-North (GOODS-N) field, meant to search for star-formation activity in a sample of redshift $1 \leq z \leq 3$ galaxies. These very deep data were observed using the Very Large Array (VLA) in the A, B, and C configurations. We present a jointly deconvolved mosaic image of our C configuration data, composed of three different approximately 5 hr scheduling blocks centered around $\alpha = 12^{h}36^{m}54^{s}$, $\delta = +62°14'15''$. We compare properties of our data, such as flux density distribution, with previous deep observations of the GOODS-N field and discuss how these properties may give us more insight into the star formation history of the universe.

P29

Yiqing Song (University of Virginia)

Sean Linden (University of Virginia)
Aaron Evans (University of Virginia, National Radio Astronomy Observatory)
Loreto Barcos-Muñoz (National Radio Astronomy Observatory)
Eric Murphy (National Radio Astronomy Observatory)

Topic: Galaxy Evolution

Unravelling the Radio Properties of Circumnuclear Starbursts in the Nearby Universe

Circumnuclear rings are excellent laboratories for studying star formation in the central 500pc of galaxies. They play a key role in understanding the co-evolution of black holes and their host galaxies. In this work, we investigate if and how the physical environment of the host galaxy (AGN, merger stage, etc.) may affect the properties of its nuclear starburst using radio/sub-mm data. We present preliminary results of a 3-33GHz JVLA study of 8 circumnuclear rings identified from the Star Formation in Radio Survey (SFRS) and the Great Observatories All-sky LIRG Survey (GOALS) at a matching physical resolution of ~100pc, supplemented with high resolution analyses of archival 3mm continuum and molecular gas ALMA data. This project pilots the technique that we will implement on our full JVLA-GOALS sample of 68 galaxies to understand resolved radio properties of local U/LIRGs compared to those of normal galaxies. It will prepare us for the coming era of highly resolved studies of star formation properties and their dependence on the local environment with the advent of new facilities such as JWST and ngVLA. NgVLA's capability to probe star formation and AGN fueling on sub-kpc scales in galaxies across wide ranges of physical environments will enable systematic multi-wavelength studies on the interplay between star formation and black hole accretion, as well as its effect on galaxy evolution.

P30

John Tobin (NRAO)

Topic: Data Processing

The NRAO Science Ready Data Products (SRDP) Project

The Science Ready Data Products (SRDP) project aims to maximize the cutting-edge science enabled by NRAO Telescopes and has currently entered its Pilot Phase. We are doing this with the primary goals of decreasing the barriers to the use of NRAO facilities by the broader astronomical community and enabling our existing users to focus more on science and less on data reduction. As such, the SRDP project is leading the development of an modern and functional archive interface to NRAO radio telescope data, both images and visibility data. The capabilities of the SRDP will be developed and rolled-out on an approximately yearly basis. The Pilot and First Wave of capabilities include:

- User-specified ALMA cube imaging (selected users for Pilot)
- Download of calibrated visibility data for ALMA
- Enhanced quality assurance for the VLA pipeline calibration (selected projects for Pilot)
- Download of calibrated visibility data for the VLA

SRDP will be essential for the development of the ngVLA as a facility for the broad astronomical community.

P31

Allison P. M. Towner (University of Virginia)

Crystal L. Brogan (NRAO), Todd R. Hunter (NRAO)

Topic: Star and Planet Formation

Surveying the Protostellar Population Powering Extended Green Objects (EGOs) with the VLA

We present 5 cm and 1.3 cm (C- and K-band) JVLA observations of 9 nascent massive protoclusters in the Milky Way. These protoclusters are typical young, massive objects with total FIR luminosities ranging from 1-40 x 10^3 $L_\odot$, and exist in a specific evolutionary state that is a) prior to the onset of significant ionization feedback and b) in which active outflows dominate their infrared appearance. These VLA observations cover known 6.7 GHz Class II CH_3OH and 22 GHz H_2O masers in these objects, as well as suspected NH_3 (3,3) and (6,6) maser transitions, and 5 cm and 1.3 cm continuum observations with sensitivities of 10-20 μJy at an angular resolution of ~0.3 arcseconds. These observations address two key areas of massive protocluster research: 1) Well-sampled SEDs for the individual protostars in these sources (including ALMA mm-wavelength observations) will allow us to disentangle the various types of centimeter-wavelength continuum emission (thermal dust, free-free, synchrotron, etc.) that may be present for each protostar, and the high angular resolution enables us to further refine the specific physical emission mechanisms (e.g. gravitationally-trapped HC HII region, ionized jet, stellar wind, etc.) in each MYSO. 2) These SEDs will also allow us to examine the demographics (evolutionary stage, mass, clustering, mass segregation if any) of each protocluster. In addition to characterizing the unique properties of each individual protocluster, we will also be able to compare our data to the predictions of current theories of massive star formation. Both goals will be significantly aided by the proposed capabilities of the ngVLA, especially in combination with existing mm-wavelength facilities (ALMA) and planned infrared facilities (JWST).

P32

Tiziana Venturi (INAF, Istituto di Radioastronomia, Italy)

Michael Lindqvist (Onsala Space Observatory, Sweden)
Zsolt Paragi (JIVE, The Netherlands)

Topic: Science Areasin cm/mm VLBI

A Scientific Roadmap for VLBI in the Next Decade

The European VLBI Network has started a process to define the new scientific roadmap for VLBI in the next decade. The new astrophysical frontiers which are opening with the current and future generation of radio interferometers, as well as several space- and ground-based facilities at other wavelengths, pose the question of the role and unique potentials of arrays with milliarcsecond and sub-mas angular resolutions at cm and mm wavelengths.

The effort, which will lead to a white paper, is being carried out in the framework of the EC-H2020 Framework Programme JUMPING JIVE and is involving several astrophysicists worldwide, with broad scientific expertise.

On behalf of the full team I will present the project, highlighting the key science areas where very long baseline interferometry will be playing a transformational role.

P33

Vicente Villanueva (University of Maryland - College Park)

Alberto Bolatto (University of Maryland), Rebecca Levy (University of Maryland), Peter Teuben (University of Maryland), Sebastián F. Sánchez (Universidad Nacional Autónoma de México), and the EDGE-CALIFA Collaboration

Topic: Galaxy Evolution

A Systematic Analysis of 126 Nearby Galaxies from the EDGE-CALIFA Survey

Observations in the mm-wave and optical bands are fundamental to determine the relation between the local and global physical properties of galaxies and the processes involved. High spatially-resolved surveys play a key role in providing information about the local physical conditions of the molecular and atomic gas and how they drive the star formation activity. The EDGE-CALIFA survey constitutes a power tool to study these relations. In this work, we present a systematic analysis of 126 nearby galaxies from the EDGE-CALIFA survey using 12CO(J=1-0) line emission detections with a typical spatial resolution of ~1 kpc, and we show results for two ongoing studies. First, we inspect the dependency of star formation efficiency on different physical parameters for ~ 3500 line-of-sight 12CO detections and we compare them with the current literature. Second, using CO and ionized gas rotational curves for the 126 EDGE-CALIFA galaxies we investigate the dynamical conditions of the molecular and atomic gas, and we mainly focus on the gravitational instabilities and midplane hydrostatic gas pressure. In future projects, we will complement these results and connect them with the kinematics of the ISM phases, feedback processes, and even higher high spatial resolution over a wide range of galaxy properties and redshifts.

P34

Erik Weaver (Rice University)

Andrea Isella (Rice University)

Topic: Planet Formation

Turbulence Measurement with the ngVLA

One of the key parameters in the planet formation process is turbulence, which governs dust settling as well as the growth of dust grains into planetesimals. Unfortunately, disk turbulence cannot be directly measured, and is difficult even to estimate. Here, we introduce a new method to estimate disk turbulence based on simple modeling and geometric arguments. This method aims to be complementary to the full forward modeling approaches currently being employed. So far, this technique has only been employed using data from ALMA, but the ngVLA is an excellent option for such studies, as it offers higher angular resolution and an unparalleled ability to probe disk dust structure.

P35

Sam Weismann (University of California - Berkeley)

Dan Werthimer (University of California - Berkeley)

Topic: Multi-Messenger Astronomy and Astrophysics

Are FRBs Giant Pulses from Pulsars? Planned Long Duration Observations of the Crab

It has been proposed that FRBs could be giant pulses from regularly pulsating sources like pulsars and magnetars. The Crab pulsar is known to occasionally emit giant pulses whose flux density is hypothesized to be a power law distribution. To verify these two claims, a team from UCB and Cornell plans to observe the Crab pulsar using the Leuschner radio telescope for at least a year in the frequency range 1.25-2.5 GHz. By observing the Crab for a longer duration than any observation so far, we hope to quantify a distribution of pulse heights and ascertain an upper limit to the flux density achieved by the largest giant pulses. We hope to begin continuous observations in June 2019.