Speaker	Session	Title & Abstract
Day 1 (May 15th)		
Julia Blue Bird	1.1	**High Redshift HI & H2 With CHILES** We know that cosmic star formation peaks at $z \sim 2$ and sharply declines to the present, yet we know very little about gas reservoirs in individual galaxies that lead to star formation through these redshifts. The COSMOS HI Large Extragalactic Survey (CHILES) is a 1000-hour program, using the Karl G. Jansky Very Large Array, that images HI in a redshift range of $0 < z < 0.5$. We present images of HI gas in galaxies at high-redshift combined with observations of CO (tracing H2) and analyze atomic + molecular gas in a small sample of galaxies three, four, and five billion years back in time.
Kimberly Emig	1.2	**Forming Molecular Clouds in Cygnus X** The rate at which molecular clouds form in the Milky Way profoundly affects the evolution of our Galaxy. The interstellar medium (ISM) transitions from an atomic to a molecular phase in cold H I gas and CO-dark molecular gas. Throughout the HI/H2 transition zone, carbon remains ionized due to its lower ionization potential (11.3 eV) than that of hydrogen. This makes ionized carbon a key observable to understand the formation of molecular clouds. Uniquely, carbon recombination lines at low radio frequencies (< 1 GHz) arise exclusively from cold (T ~ 20-100 K) and diffuse (n_H ~ 100 -- 1000 cm-3) gas that is thought to be typical of this transition zone. Using the Green Bank Telescope at 340 MHz, we mapped carbon radio recombination lines (CRRLs) over 30 square degrees in Cygnus X. Cygnus X (D ~ 1.5 kpc) is a massive star-forming complex with >160 OB stars present and a reservoir of >10^6 M_sun of molecular gas. CRRLs are detected in the majority of the survey region. They reveal the morphology of cold diffuse gas, which is systematically offset from CO-traced molecular gas. And they are also revealing the kinematics and importance of gas motions in forming molecular clouds.
Tao-Chung Ching	1.3	**Zeeman effect of the HI narrow self-absorption line, a new systematic probe of magnetic field in molecular clo** Magnetic fields have an important role in the evolution of interstellar medium and star formation. As the only direct probe of interstellar field strength, credible Zeeman measurements remain sparse owing to the lack of suitable Zeeman probes, particularly for cold, molecular gas. Here I report the Zeeman measurements through the HI narrow self-absorption (HINSA) using the FAST and VLA telescopes toward low-mass prestellar cores. The strengths and structures of magnetic fields in the cores revealed by FAST are different from the classical picture where magnetically supercritical cores form out of magnetically subcritical envelopes. The VLA HINSA Zeeman results at high angular resolution show a steep correlation between field strength and gas density. The FAST and VLA results suggest a more efficient mechanism to dissipate magnetic flux than the classical mechanism of ambipolar diffusion. The FAST and VLA results also indicate that HINSA can become as a new systematic Zeeman probe.
Jesse Bublitz	2.1	**Radio/Optical Maps of Planetary Nebulae to Uncover Their History** Planetary nebulae represent the end stages of over 90% of all stars in the Universe. They also provide ideal testbeds for the study of irradiated cold gas environments. With my work mapping the atomic/molecular structure of planetary nebulae, I seek to understand their evolutionary history and how the processes of ejection, jets, and photodissociation affect the contribution of material back into the ISM for the next cycle of stellar and planetary formation. I will share my findings from two planetary nebulae and how their chemistry informs the process of stellar death.
Dana Baylis-Aguirre	2.2	**Line Dancing in Mira Atmospheres** I will present circumstellar analysis of oxygen-rich (M-type) Mira variables. These highly evolved low-to-intermediate mass stars are characterized by their efficient dust and molecule production, making them excellent laboratories for studying enrichment processes within circumstellar environments (CSEs). I combined spectral analysis of Spitzer Infrared Spectrograph (IRS) observations with optical/near-IR interferometric measurements taken with the Palomar Testbed Interferometer (PTI) to provide unprecedented access to dust and molecule production region of M-type atmospheres. In the Spitzer spectra I have identified several ro-vibrational Q-branch bandheads of CO2 that are not observable with ground based instruments because telluric features dominate at these wavelengths. These features appear to “dance” and exhibit dynamic behavior that is likely tied to the pulsational nature of the atmosphere. I adapted the radiative transfer code RADEX for use at wavelengths between 10-20 µm to model these features. The RADEX models provide physical characteristics of the gas such as kinetic temperature, density, and optical depth. Meanwhile, we have ~10 years of interferometric measurements taken with PTI that when combined with parallax distances to the stars provide a direct measurement of the radial size of the star (among other fundamental parameters). Combining the physical size of the star with RADEX models determines the emitting region of the gas, allowing us to fully characterize the gas in the circumstellar environment. This approach has led us to observational evidence of a “refrigeration zone” between 2-5 R★ where the temperature radically departs from equilibrium predictions, which can have profound impact on dust formation.

Michael Rugel	2.3	**Properties of the interstellar medium in different Galactic environments** What are the dynamics and properties of atomic and molecular gas in the innermost regions of our Galaxy? How does it compare to other parts of the Galaxy? We extended the HI, OH, recombination line survey of the Milky Way (THOR) to the Galactic center, simultaneously observing HI, four OH, 12 radio recombination lines as well as the L-band continuum between 1-2 GHz in full polarization, to study the interstellar medium (ISM) and star formation in the extreme conditions of the Galactic Center. Tracing the atomic, molecular and ionized gas components of the ISM, these multi-line and continuum observations allow us to address the dynamics of atomic and molecular gas in the Galactic Center. Further constraints on gas properties across the entire Galaxy are derived from additional deep observations of cm transitions of HI and OH, which were obtained as follow-up observations to the THz ground state SOFIA legacy survey HyGAL I will give an overview on these surveys and other projects related to star formation and structure of our Galaxy, and show initial results.
Tasha Gautam	3.1	**Detection of relativistic effects in PSR J1952+2630 and PSR J1012-4235** Millisecond pulsars are a class of recycled pulsars that rotate with exceptionally small spin periods (<20ms). They are extremely stable in their rotation which makes them exceptional probes to a plethora of multifaceted applications to science. One of the crucial applications of these systems is that they have the potential to provide stringent constraints on the equation of state of neutron stars, thus providing insight into the nature of the dense matter inside. In this talk, I will discuss the results of long-term radio timing analysis of two millisecond pulsars: PSR J1952+2630 and PSR J1012-4235, both of which provide exceptional timing precision. I will talk about derived constraints on the nature of each of these binary systems as a result of this analysis. In addition, I will discuss the relativistic effects detected in these systems, and the constraints derived on the pulsar and its companion's mass. I will also talk about the future potential of these systems in testing General Relativity and constraining alternative theories of gravity
Dillon Dong	3.2	**Slow radio transients as signposts for discovering the unknown** Thanks to the ever-increasing quality of all-sky (and sometimes multi-epoch) surveys from radio to gamma ray wavelengths, it is now possible to point at nearly any direction in the sky and make meaningful statements about the astronomical objects that may or may not be present in that direction. This wealth of data already contains the information required to discover entirely new astronomical source classes. Two of the biggest missing ingredients are: (1) knowing where to look, and (2) having the right theoretical framework to interpret what's there. In this talk, I will give an overview of current efforts by myself and my collaborators to discover radio transients in the VLA Sky Survey and interpret them with observations (archival and follow-up) and theory. I will also discuss two published examples of new transient source classes (a compact object/massive star merger, and an emerging pulsar wind nebula) and the connection between these objects and an emerging picture of massive stars and the remnants they leave behind.
Day 2 (May 16th)		
Elisabeth A.C. Mills	Keynote	**Hidden Engines: Uncovering the Workings of the Nearest Galaxy Centers** Centers of galaxies are some of the most extreme objects in our universe: hosting starbursts and active supermassive black holes that can launch jets and winds far outside the compact galaxy nucleus. The effects of the unique interactions between stars, gas, and black holes that occur here don't just stay confined to these small regions: they have an outsized influence on the overall evolution of galaxies as a whole. At just 8.1 kpc away, the center of the Milky Way is unparalleled in its proximity, making it the best laboratory for detailed studies of the processes that govern and define galaxy nuclei. However, the Galactic center also presents a big challenge for these studies: it is a relatively quiet environment. Few stars are forming in this region, and the black hole is not active. Clearly, it hasn't always been this way: from the Fermi Bubbles to hundred-year old echoes of X-ray bursts there are many relics of an active past in the center of our own Milky Way. We also know our Galaxy center likely won't stay quiet for long: it contains a sizable reservoir of molecular gas that is the fuel for future star formation and black hole accretion. In this talk I will present the results of research following the gas and its properties from kiloparsec to sub-parsec scales to understand why the Galactic center is so quiet right now and what the future holds. Finally, I will discuss ongoing work to increase the sample size of galaxy nuclei with parsec-scale gas measurements, and what this means for putting the Galactic center in context with its more active neighbors.

Chenoa Tremblay	4.1	**The Cosmic Dance of Andromeda & The Milky Way** The milky way is part of a local group of galaxies where M31 or the Andromeda galaxy, Andromeda's satellite galaxy M33 and the Milky Way making up the bulk of the dynamical forces in the group. So we need to answer one of the biggest unknowns about the transverse motion of M31 with respect to the Milky Way. By deriving this value we can accomplish a number of goals which will impact the expected future of the Milky Way and goes a long way in understanding its past. By knowing the transverse motion we can test different gravitational models for the local group and compare this with our expectation for galaxy formations. Currently, our observations suggest that either the local group is unique or we have a gap in our knowledge of out galaxy formation works. It would also be good to know if the Milky Way and M31 have brushed past each other in the past and will they collide in the future. If so, on what time scales exactly. I will talk about our search for point sources throughout M31 to track its transverse motion.
Emily Moravec	4.2	**The formative and explosive physics of merging galaxy clusters** In this talk, I will explore the effects of merging galaxy clusters on cluster formation and cluster galaxy populations. First, I will present multiwavelength evidence of shocks in the highest redshift cluster-cluster merger found to-date using radio and X-ray data. Second, I will present the progress of an investigation of the connection between radio-AGN and properties of their host galaxy cluster at z~1 using VLA data. And lastly, I will talk about the effect of merging clusters on the morphology of radio-AGN in a low redshift sample of merging and non-merging clusters.
Pallavi Patil	4.3	**Multiwavelength Study of Heavily Obscured Quasars with Young Radio Jets at Cosmic Noon** AGN feedback at $z \sim 1$-3 is believed to occur in the presence of thick columns of gas and dust, leading to heavily obscured systems that are challenging to detect at optical/X-rays but are transparent at radio and MIR wavelengths. By combining MIR and radio diagnostics, we have identified a sample of 155 ultra-luminous and obscured quasars ($0.4 < z < 3$) selected to have extremely red MIR colors in WISE and compact, bright radio emission in the NVSS/FIRST. In this talk, I will present our ongoing multiwavelength efforts to understand the nature of this unique sample in the context of jet-ISM feedback. High-resolution studies with VLA and VLBA confirm that most of the sample is compact with angular scales <0.2” (1.7 kpc at z~2). A radio spectral analysis reveals many sources show peaked/curved spectra consistent with being young radio AGN. I will then focus on a well-studied prototype source from our sample. Our follow-up study includes deep multi-frequency VLA imaging and 870μm ALMA continuum and line (CO and HCN) observations, LBT imaging and spectroscopy, and NuSTAR data revealing a Compton-thick AGN. Overall, our sample is consistent with a population of recently triggered, young radio jets caught in a unique evolutionary stage in which they reside in a dense ISM.
Bang Nhan	5.1	**Radio telescope's antenna design and beam pattern characterization techniques** Radio telescopes have improved drastically in both spectral and spatial resolutions since the early radio antenna developed by Karl Guthe Jansky at Bell Lab in 1932. They enable astronomers to study the chemical compositions and dynamics of distant galaxies within the intergalactic medium (IGM). To recover accurate brightness temperature (or flux) level of astronomical sources, the spectral and spatial responses of the telescopes need to be characterized and calibrated. The telescope’s antenna farfield beam patterns can provide those required information. Conventional beam correction approaches typically include observing well-known bright reference sky sources and correcting the antenna gain offset against cataloged levels, beam modeling with a simple Gaussian profile or high-order Zernike polynomial fitting, as well as computational electromagnetic (CEM) simulation, in conjunction to antenna range feed measurement. In this talk, I will provide an overview on the instrument concept design and observation strategy of the Scaled-Antenna For Ascertaining the Radio Index (SAFARI), as a specific use case of radio telescope to achieve a spectrally-flat antenna response for sky-averaged (global) 21-cm cosmology below 200 MHz. Additionally, I will also present an antenna beam pattern measurement technique, the In-situ Beam Mapper (IBeaM), using low Earth orbit (LEO) satellite constellations, such as Orbcomm (downlink at 137-178 MHz) and Starlink (downlink at 10-12 GHz), to constrain radio telescopes beam pattern from new and archival observation data sets.

Savin Shynu Varghese	5.2	**An All-Sky Commensal SETI Survey with the Very Large Array** The search for extra-terrestrial intelligence (SETI) addresses one of the most profound questions in science: Are we alone in this universe as an intelligent species? This search process is extremely challenging as it requires exploring the vast SETI parameter space in terms of time, location, frequency and duty cycle. Most of the past ETI searches focused on using large single dish telescopes and they have covered only a tiny fraction of this parameter space. Interferometers offer certain advantages over large single dish telescopes in terms of larger sky coverage and faster survey speed. In order to maximize the detectability of the ETI signals, the SETI Institute and the National Radio Astronomy Observatory (NRAO) in collaboration have developed a new commensal observing system with the Very Large Array (VLA) radio telescope in New Mexico. This new system is known as COSMIC - Commensal Open Source Multimode Interferometer Cluster. With COSMIC, the data streams from the VLA antennas are split before going to the VLA correlator and an independent copy is sent to the COSMIC compute cluster. This will allow COSMIC continuous access to the VLA data streams which can be used for ETI searches. This will allow us to conduct one of the most comprehensive searches for extra-terrestrial life. The first phase of COSMIC is completed and the system is currently collecting data along with the third epoch of the VLA Sky Survey (VLASS) started in January 2023. The VLASS is a fast sky scan survey covering the entire Northern hemisphere above a declination of -40 degrees at S band. The data collected from VLASS survey is used to commission the observing system and conduct its first SETI survey. This will enable COSMIC to observe several million stars within the first 2 years of operation with a sensitivity good enough to detect an Arecibo-like transmitter at a distance of 25 pc from Earth. In this talk, we will focus on the recent developments of COSMIC and the status of the ongoing science commissioning and the SETI survey.
Rebecca Charbonneau	5.3	**Early VLBI Experiments and Global Cooperation in Radio Astronomy** This talk will focus on the first Very Long Baseline Interferometry experiment conducted by NRAO astronomers and a group of Soviet astronomers in the late 1960s. In doing so, we will explore how the internationalist perspectives of the astronomers involved aided the success of the experiment, despite the many challenges of scientific collaboration during the Cold War period. We will look at how these early experiments shaped the character of global cooperation in radio astronomy up to the present day.