Talk Sessions: **Murphy McPhee Auditorium, Westerman Hall (120)**
Poster Sessions: **Engineering Lobby (adjacent to Murphy McPhee)**

Friday November 3

Social Hour & Snacks	*1:00 – 2:00pm*
■ *Westerman 136*	
Registration	2:00 – 2:45pm
Session 1	3:00 – 4:15pm
Posters / Coffee	4:15 – 4:45pm
Session 2	4:45 – 6:00pm
Conference Dinner	*6:30pm*
■ *RSVP Required*	

Saturday November 4

Continental Breakfast Provided

Registration	8:00 – 8:30am
Session 3	8:45 – 10:00am
Posters / Coffee	10:00 – 10:30am
Session 4	10:30 – 11:45am
Lunch (provided)	11:45am – 12:45pm
Keynote	12:45 – 1:45pm
Posters / Coffee	1:45 – 2:15pm
Session 5	2:15 – 3:45pm
Posters / Coffee	3:45 – 4:15pm
Session 6	4:15 – 5:30pm

Friday November 3

2:00 – 2:45pm **Registration**

Session 1

Chair: Mark Brodwin, University of Missouri – Kansas City

3:00pm **Ashley Lieber** **University of Kansas**
Parsec Scale Excitation Analysis of Dense Gas in the NGC 253 Starburst Nucleus

3:15pm **Kimberly Conger** **University of Kansas**
Virgo WISESize: Investigating Environmental Processing of Galaxies in the Virgo Cluster

3:30pm **Xinyu Mai** **University of Kansas**
Exploring the Heart of the Milky Way: The Gas Kinematics in the Central Parsecs

3:45pm **Amirnezam Amiri** **University of Arkansas**
HOMERUN: A New, Multi-Cloud Method to Accurately Model Emission Lines
in Star-Forming Galaxies

4:00pm **Alec Martin** **University of Missouri - Columbia**
Properties of Giant Star-Forming Clumps and Their Host Galaxies Observed by HST
and JWST in UVCANDELS

4:15 – 4:45pm **Poster Session & Coffee Break**

Session 2

Chair: Christopher Shingledecker, Benedictine College

4:45pm **David Coria** **University of Kansas**
Tracing Giant Exoplanet Formation Using Complementary Host Star CNO Abundances

5:00pm **Yoni Brande** **University of Kansas**
Clouds and Clarity: Revisiting Atmospheric Feature Trends in Neptune-size Exoplanets

5:15pm **Alex Polanski** **University of Kansas**
The TESS-Keck Survey: 10,000 Radial Velocity Points Providing Mass Constraints on 127 Planets

5:30pm **Neda Hejazi** **University of Kansas**
Chemical Composition of Planet-Host Cool Dwarfs: The Interplay with Planetary Formation

5:45pm **Joseph Hand** **University of Kansas**
Identifying Potential Technosignatures in APOGEE Data Using ALIAS

Saturday November 4

8:00 – 8:30am **Registration** *Continental Breakfast Provided*

Session 3

Chair: Yicheng Guo, University of Missouri – Columbia

8:45am **Vicki Kuhn** **University of Missouri - Columbia**
JWST Reveals a Surprisingly High Fraction of Galaxies Being Spiral-like at $0.5 \leq z \leq 4$

9:00am **Vishal Jayswal** **University of Missouri - Columbia**
A Point Mass Placed in Cosmological Background

9:15am **Julianna Bayless** **University of Missouri - Columbia**
Studying Gravitational Lensing in the Early Universe with the James Webb Space Telescope: I. Observation

9:30am **Ellie Gates** **University of Missouri - Columbia**
Studying Gravitational Lensing in the Early Universe with the James Webb Space Telescope: II. Modeling

9:45am **Juventud Luna** **University of Missouri - Kansas City**
Characterizing Response of the LuSEE-Night Spectrometer

10:00 – 10:30am **Poster Session & Coffee Break**

Session 4

Chair: Allison Kirkpatrick, University of Kansas

10:30am **Brandon Coleman** **University of Kansas**
Finding Rare AGN: Investigating the Evolution of Cold Quasars

10:45am **Thresa Kelly** **University of Kansas**
A Multiwavelength Comparison of X-ray and Infrared Selected Active Galactic Nuclei

11:00am **Kurt Hamblin** **University of Kansas**
Utilizing Probabilistic forecasting to identify AGN in JWST

11:15am **Mark Brodwin** **University of Missouri - Kansas City**
X-ray AGN in Dynamically Active Massive Galaxy Clusters at $z \sim 1$

11:30am **Gregory Troiani** **University of Kansas**
PRIMER: New Eyes on the Sky

11:45am – 12:45pm **Lunch (provided)**

12:45 – 1:45pm **Brandon Marshall** **University of Nebraska – Kearney**
The Midwestern O Star VES 735 (Keynote)

Saturday November 4 (Cont.)

1:45 – 2:15pm **Poster Session & Coffee Break**

Session 5

Chair: Bret Lehmer, University of Arkansas

2:15pm Lucia **Fisher & Timothy Rosno** **Benedictine College**
Photometric and Spectroscopic Study of the SRD variables V441 Her and UU Her

2:30pm **Matthew Millard** **University of Iowa**
A Review of High-resolution X-ray Spectroscopic Studies of Type Ia Supernova Remnants

2:45pm **Joseph Wandishin** **Benedictine College**
Ozone Reactions Occurring in the Interiors of Protoplanetary Ice Grains

3:00pm **Harry O'Mara** **University of Arkansas**
MiSaTaQuWa Equations in a Plane Wave Spacetime

3:15pm **Joel Berrier** **University of Nebraska – Kearney**
A Technique to Estimate LISA Signal Confusion Noise

3:30pm **Andrii Dzygunenko** **Andover Central High School**
Period Analysis of 3 Eclipsing Binary Stars with TESS Data

3:45 – 4:15pm **Poster Session & Coffee Break**

Session 6

Chair: Gregory Rudnick, University of Kansas

4:15pm **Bret Lehmer** **University of Arkansas**
X-ray Binary Population Luminosity Functions in Galaxies and their Dependence on Star-Formation History and Metallicity

4:30pm **Byron Morales Maldonado** **University of Kansas**
Environmental Effects on the Gas Contents of GOGREEN Passive Galaxies

4:45pm **Adriana Feener-Rivera & Jennifer Vanderslice**
University of Missouri - Kansas City
MaDCoWS II: A First Look at a New, High-z Galaxy Cluster Survey

5:00pm **Joseph Huber** **University of Missouri - Kansas City**
An X-ray Probe of High-redshift Galaxy Clusters in the MaDCoWS Surveys

5:15pm **Rachel Cionitti** **University of Missouri - Kansas City**
Passive Fractions of Massive and Distant Clusters of WISE (MaDCoWS) Member Galaxies

POSTERS

Amirnezam Amiri **University of Arkansas**
Gas-Phase metallicity measurement of the Seyfert galaxy NGC-7130

Michael Bandemer **University of Arkansas**
Generating Realistic Synthetic X-ray Binary Population Luminosity Functions with POSYDON

Benjamin Bogner **University of Arkansas**
Timing Trends in the Calculation of Moderate Eccentricity EMRI Gravitational Waves

Craig Brooks **University of Kansas**
Multiwavelength deconvolution of cluster galaxies at redshift z ~ 1.3

Keaton Donaghue **University of Kansas**
Optical Depth and Temperature of Dust Surrounding Massive Clusters in NGC 253

Madeleine Del Endecott **University of Kansas**
Observation and Data Refinement of Young Open Clusters as Tracers of Galactic Environment

Donovan Flagg **University of Missouri - Columbia**
Measuring the Pitch Angle of High Redshift Galaxies

Emerson Gehr **University of Arkansas**
Modeling Spectra of X-Ray Binaries Across Galaxy Types

Don Hilary Sanjaya Hettiarachchi **University of Arkansas**
Theoretical Study of Density Wave Theory and a Consistent Set of Scaling Relations for Spiral Galaxies with Inner and Outer Arm Structures.

Duy Huynh **University of Kansas**
Adding Archival Herschel Space Observatory Data to Complement the Virgo Filament Survey

Madison Norwood **University of Arkansas**
New X-ray Spectral Constraints for Luminous Infrared Galaxies: A Case Study of NGC 3221

Ryder Smith **University of Arkansas**
Spectral Modeling of Star-Forming Regions in M83: Insights into the Interstellar Medium

Zachary Wilson **University of Arkansas**
Using X-ray Colors to Quantify Spectral Diversity of X-ray Binary Populations in M83

Parker Wise **University of Kansas**
Measuring Accurate Masses in a Protocluster Source in the Galactic Center

ABSTRACTS

Session 1, Friday Nov 3

3:00pm **Ashley Lieber** **University of Kansas**

Parsec Scale Excitation Analysis of Dense Gas in the NGC 253 Starburst Nucleus

We present an initial excitation analysis of several dense-gas-tracing molecules in the NGC 253 starburst nucleus using high-resolution (< 5 pc) ALMA observations at multiple frequencies in Bands 3 (84 GHz), 7 (350 GHz), and 9 (690 GHz). The environment of the NGC 253 nucleus is far more extreme than that of the Milky Way's center: it has a central star formation rate that is 40 times higher and is actively driving a massive molecular outflow. As one of the nearest examples of a nuclear starburst (D = 3.5 Mpc), it is a prime candidate for a detailed study of dense gas physical conditions in an extreme star formation environment. The purpose of our work is to measure the number density of gas in this environment to test theories predicting an environmentally-dependent density threshold for star formation. We analyze multiple rotational transitions of isotopologues of HCN and HCO^+ to constrain both the gas opacity and the excitation. Our results will then be compared to analogous studies of the centers of the Milky Way and other nearby galaxies to understand and quantify differences in gas physical conditions that result in different levels of star formation in the environment of galaxy nuclei.

3:15pm **Kimberly Conger** **University of Kansas**

Virgo WISESize: Investigating Environmental Processing of Galaxies in the Virgo Cluster

The cosmic web of the Universe consists of a patchwork of dense clusters and empty voids, with strands of filamentary networks connecting and feeding these central clusters. Observations have demonstrated that these clusters harbor a lower fraction of star-forming galaxies relative to the isolated galaxies of the field; but astronomers have largely "washed out" filaments in their descriptions of cosmic environments, considering only the distance from the cluster center. Recent large-scale hydrodynamic simulations, however, have revealed filaments to be non-negligible sites of preprocessing as galaxies funnel through these networks into the high density clusters. The aim of the Virgo WISESize project is to directly probe galaxies in a more nuanced range of environments, using a combination of infrared and optical wavelength bands to measure extrinsic galaxy quenching in and surrounding the Virgo cluster. In particular, we compare the spatial extent of obscured star formation to that of the stars, using the ratio to quantify the processing of a galaxy's gas reservoir in a given environment. We then analyze these results in the context of semi-analytic models which predict how size ratio trends vary according to what physical processes are at play. We ultimately will identify which mechanisms are contributing to the processing of galaxies in these different environment regimes, and in so doing help improve prevailing models of galaxy evolution.

3:30pm **Xinyu Mai** **University of Kansas**

Exploring the Heart of the Milky Way: The Gas Kinematics in the Central Parsecs

The Circumnuclear Disk (CND) is a ring of dense gas that lies within 2 - 5 parsecs of the Milky Way's central supermassive black hole. The CND (M_{gas}~$10{,}000 M_{\odot}$) is the closest major reservoir of matter that could accrete onto the black hole, making it a crucial laboratory for understanding how central concentrations of gas drive inflows and correlate with central activity over cosmic time. We present preliminary maps of the CND with 1.5" (0.06 pc) resolution made from ALMA observations of SO, a high-density gas tracer. By analyzing these molecular line observations, we resolve individual gas clumps and filamentary features and can infer their relations to the ionized gas in Sgr A West, as well as possible interactions with two nearby giant molecular clouds. We perform a kinematic decomposition of the ALMA SO data using a newly developed Python implementation of the spectral line fitting algorithm SCOUSE. We fit the spectra with individual Gaussian profiles in order to model the full complexity of spectral lines in this source. This allows us to separate the CND into individual, kinematically-distinct components and measure where the gas is located, how fast it is moving, and follow its physical conditions as it gets closer to the black hole. The detailed analysis enabled by these observations will allow us to ultimately understand how similar structures arise in other galaxies and impact the physics of black hole growth.

3:45pm **Amirnezam Amiri** **University of Arkansas**

HOMERUN: A New, Multi-Cloud Method to Accurately Model Emission Lines in Star-Forming Galaxies

The abundance of chemical elements across cosmic time provide unique information on the physical processes driving the evolution of galaxies. Current methods for measuring gas-phase metallicities, based on either direct measurements of electron temperature (T_e) or calibrations from strong nebular emission line ratios, are based on simplifying assumptions and do not adequately describe the complexity of the emitting regions. We present a new approach based on fitting galaxy spectra with multi-cloud photoionisation models. Unlike current methods, based on comparisons with single-cloud models, our methodology is able to reproduce all observed emission lines to a very high accuracy, down to a few percent, thus allowing for accurate metallicity measurements. We further recover the well known trends between ionization parameter and metallicity, and between the Nitrogen and Oxygen abundances. Our models accurately reproduce the auroral-to-nebular line ratios, while the results of the standard T_e method are sometimes very different from the best-fitting model metallicity. We finally present newly calibrated metallicity estimators for galaxies based on ratios between strong emission lines.

4:00pm **Alec Martin** **University of Missouri - Columbia**

Properties of Giant Star-Forming Clumps and Their Host Galaxies Observed by HST and JWST in UVCANDELS

Giant star-forming clumps are a prominent feature of star-forming galaxies (SFGs) and contain important clues on galaxy formation and evolution. We used the HST/WFC3 F275W images from the Ultraviolet Imaging of the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (UVCANDELS) to investigate the basic demographics of clumps and clumpy galaxies at redshift $0.5 \leq z \leq 1$, connecting two epochs when clumps are common (at cosmic high noon, $z \sim 2$) and rare (in the local Universe). We found that clumpy galaxies are on average larger in size, higher in SFR and bluer in color than non-clumpy SFGs of the same mass. They are, however, similar in overall morphology to nonclumpy SFGs as indicated by their Sérsic index. We also found that on average, more luminous star-forming regions reside in more luminous, smaller, and/or higher-specific SFR galaxies and are found closer to their hosts' galactic center. Our results are consistent with in-situ clump formation through violent disk instability. We combined HST images with JWST CEERS images to measure the photometry of clumps over a wide range of wavelengths from rest-frame UV to rest-frame NIR. We also ran Bayesian SED- fitting to measure the physical properties of clumps (M*, SFR, age, and A_v). These properties will be compared to the state-of-the art simulations to constrain the effects of feedback on clump evolution.

Session 2, Fri Nov 3

4:45pm **David Coria** **University of Kansas**

Tracing Giant Exoplanet Formation Using Complementary Host Star CNO Abundances

The abundances of volatile elements like carbon, oxygen, and nitrogen can trace a planet's formation location relative to H_2O, CO_2, CO, and N_2 "snowlines", or the distance from the star at which these volatile elements sublimate. By comparing the C/O and $^{12}C/^{13}C$ ratios measured in giant exoplanet atmospheres to complementary measurements of their host stars, we can determine whether the planet inherited stellar abundances from formation inside the volatile snowlines, or non-stellar C/O and ^{13}C enrichment characteristic of formation beyond the snowlines. To date, there are still only a handful of exoplanet systems where we can make a direct comparison of elemental and isotopic CNO abundances between an exoplanet and its host star. Here, we present a $^{12}C/^{13}C$ abundance analysis for host star WASP-77A. We use MARCS stellar atmosphere models and TurboSpectrum spectral synthesis code to generate synthetic stellar spectra for line identification and isotopic abundance calculations. We report a super-solar $^{12}C/^{13}C$ ratio (~103) for WASP-77A, which is inconsistent with the sub-solar $^{12}C/^{13}C$ ratio (< 40) reported for its companion planet and points to the planet's formation beyond the CO snowline. WASP-77 Ab's C/O ratio also points to formation beyond the H2O snowline, and together the C/O and $^{12}C/^{13}C$ ratios of WASP-77 Ab provide chemical evidence for the planet's migration to its current location ~0.024 AU from its host star.

5:00pm **Yoni Brande** **University of Kansas**

Clouds and Clarity: Revisiting Atmospheric Feature Trends in Neptune-size Exoplanets

Over the last decade, precise exoplanet transmission spectroscopy has revealed the atmospheres of dozens of exoplanets, driven largely by observatories like the Hubble Space Telescope. One major discovery has been the ubiquity of atmospheric aerosols, often blocking access to exoplanet chemical inventories. Tentative trends have been identified, showing that the clarity of planetary atmospheres may depend on equilibrium temperature. Previous work has often grouped dissimilar planets together in order to increase the statistical power of any trends, but it remains unclear from observed transmission spectra whether these planets exhibit the same atmospheric physics and chemistry. We present a re-analysis of a smaller, more physically similar sample of 15 exo-Neptune transmission spectra across a wide range of temperatures (200 - 1000 K). We identify a parabolic trend in the water feature amplitude (A_H) with a minimum near 627 K. Our sample is consistent with either very low cloud sedimentation efficiency (f_{sed} ~ 0.01) and high (100x Solar) metallicity, or small (r = 0.01 micron) haze particles and small (1%) precursor conversion. There is an intrinsic astrophysical scatter of ~0.5 scale height, perhaps evidence of stochasticity in these planets' formation processes. Observers should expect significant attenuation in transmission spectra of Neptune-size exoplanets, up to 6 scale heights for equilibrium temperatures between 500 and 800 K. With JWST's greater wavelength sensitivity, colder (< 500 K) planets should be high-priority targets given their comparative rarity, clearer atmospheres, and the need to distinguish between the "super-puffs" and more typical gas-dominated planets.

5:15pm **Alex Polanski** **University of Kansas**

The TESS-Keck Survey: 10,000 Radial Velocity Points Providing Mass Constraints on 127 Planets

The launch of JWST has revolutionized exoplanet science by enabling detailed analysis of planetary atmospheres. However, it has also emphasized the ongoing significance of ground-based observations in understanding these systems. Keck's High Resolution Echelle Spectrograph (HIRES) has been at the forefront of such observations for the past three decades, paving the way for its successor, the Keck Planet Finder. In this talk, I will present the outcomes of a synergistic effort between HIRES and the Transiting Exoplanet Survey satellite: the TESS-Keck Survey. Our primary objective was to obtain precise mass measurements for a selection of 85 TESS Objects of Interest. Over a span of three years, we have produced mass constraints for 128 candidate planets. This dataset not only constitutes one of the largest collections of radial velocity data and planet masses to date but also is a testament to HIRES' capabilities as its time as Keck's primary planet hunter comes to a close.

5:30pm **Neda Hejazi** **University of Kansas**

Chemical Composition of Planet-Host Cool Dwarfs: The Interplay with Planetary Formation

Since a large fraction of stars harbor at least one planet, the formation of planets around newly forming stars appears to be a common phenomenon. Planet cores are believed to grow by accreting materials from a protoplanetary disk spinning around its host star. This host star has a strong impact on the properties of the protoplanetary disk, and inversely, the accretion of planetary material into the star may change the stellar elemental abundances. In addition, the relative enrichment of refractory and volatile materials as well as some pivotal abundance ratios such as C/O between planet and its host star depends on whether the planet is formed interior or exterior to the ice line, and whether the planet has undergone a kind of migration. The comparison between the chemical properties of planets and those of their parent stars could therefore provide critical information about the formation and evolutionary pathways of planetary systems. While JWST is now measuring the atmospheric chemical composition of planets with unparalleled accuracy, the elemental abundance measurement of cool dwarfs, whose orbiting planets are most sensitive to widely used exoplanet detection techniques, has still remained challenging. Due to the dominant molecular lines, the methods such as equivalent width analysis, that are readily used to obtain chemical abundances of hotter stars, do not apply to the spectra of cool dwarfs. We thus present an iterative synthetic model fitting using MARCS model atmospheres and the spectral synthesis code TurboSpectrum to determine the elemental abundances of JWST cool host stars (3100 K < T_{eff} < 4700 K) whose planetary atmospheric compositions will also be measured. We employ the high-resolution

(R = 45,000), NIR spectra observed by Gemini-S/IGRINS to measure the abundances of key chemical elements: C, O, Na, Mg, Al, K, Ca, Ti, and Fe in all stars, as well as N, Si, V, Cr, Mn, and Ni in warmer stars. Owing to the growing number of stars with confirmed planet(s), we are aiming to automate our fitting pipeline, which could be a promising method to measure the composition of stars hosting planets that will be targeted by future surveys such as PLATO and Ariel missions.

5:45pm **Joseph Hand** **University of Kansas**

Identifying Potential Technosignatures in APOGEE Data Using ALIAS

ALIAS is a tool under active development to identify potential technosignatures in the near-infrared spectra of the APOGEE dataset. This current work concerns a collection of 1200 solar-type stars selected from the dataset for an initial search. Technosignature searches are one of the primary methods used in the Search for Extraterrestrial Intelligence (SETI), most of these searches are conducted at radio frequencies using large radio telescopes, such as the Greenbank telescope, and interferrometers, such as the Very Large Array. However, technosignatures could also be found in other parts of the electromagnetic spectrum, most notably the optical and near-infrared bands. This is especially the case given current laser technology, which offer a much more directed form of communication than is possible with radio technology. Although there have been several searches in the optical, there has not been much corresponding research in the near-infrared, which is the hole ALIAS intends to fill. This talk discusses the development of ALIAS as well as its initial results.

Session 3, Sat Nov 4

8:45am **Vicki Kuhn** **University of Missouri - Columbia**

JWST Reveals a Surprisingly High Fraction of Galaxies Being Spiral-like at $0.5 \leq z \leq 4$

Spiral arms are one of the most important features used to classify the morphology of local galaxies. The cosmic epoch when spiral galaxies first appeared contains essential clues to their formation mechanisms as well as the overall galaxy evolution. In this letter, we used all ten pointings of the Cosmic Evolution Early Release Survey using the James Webb Space Telescope (JWST) to visually inspect galaxies with redshift $0.5 \leq z \leq 4$ and stellar mass $\geq 10^{10} M_{\odot}$. Out of 873 galaxies, 216 were found to have a spiral structure. We have found that the observed fraction of spiral galaxies using JWST is higher than the fraction observed with HST. The observed spiral fraction is 48% at $z = 0.5$ and decreases to 8% at $z \sim 2.75$. We even detect possible spiral-like features at redshifts $z > 3$. We artificially redshift low-z samples of our galaxies to high-z to evaluate observational biases. By comparing the input spiral fraction of the redshifted samples to the actual observed fraction, we are able to rule out the spiral fractions being < 20% for real galaxies at $z = 2.75$. Our results also show that the spiral galaxies in our sample have higher star formation rates (SFRs) and larger sizes than non-spiral galaxies.

9:00am **Vishal Jayswal** **University of Missouri - Columbia**

A Point Mass Placed in Cosmological Background

We consider the Friedmann universe which is taken as a cosmological background manifold, with a point mass m placed on the manifold. The placement of the point mass perturbs the gravitational field (spacetime geometry) of the Friedmann universe. To describe such perturbation of space-time one needs to build a genral metric which should reduce to the Schwarzschild metric as well as to the Friedmann–Lemaıtre-Robertson–Walker (FLRW) metric. We focus on two different approaches to build this model: one made by McVittie (1933) and the other one made by Lasenby and his collaborators (NLH 2012). McVittie uses the power series method of solving Einstein's field equations and Lasenby uses tetrad formalism. We develop McVittie's metric in local coordinates, which is originally in global coordinates. With the McVittie metric in the local coordinates we derive equations of motion for a test particle moving around the point mass m placed in the cosmological background. The resultant differential equations with respect to time are for each of six osculating elements: semi-major axis a, eccentricity e ($0 \leq e < 1$), the inclination i, the longitude of the ascending node Ω, the argument of pericenter ω, and the mean anomaly at the epoch l_o. The solutions of these differential equations are the first-order perturbations that explain in detail the orbit of the test particle due to: General Theory of Relativity, Hubble parameters, and the curvatures of the universe.

9:15am **Julianna Bayless** **University of Missouri - Columbia**

Studying Gravitational Lensing in the Early Universe with the James Webb Space Telescope: I. Observation

The universe consists of three components: ordinary matter, dark matter, and dark energy. Among them, dark matter makes up 28% of our universe and 85% of the total mass of the universe. However, dark matter does not interact with the electromagnetic field and can only be detected through gravitational effects. One such effect is gravitational lensing, which occurs when massive objects such as galaxies or clusters of galaxies bend the light of objects behind them. James Webb Space Telescope's (JWST) infrared capabilities and high spatial resolution open a new window to detect this phenomenon in the distant (and hence early) universe. Using data from JWST's Cosmic Evolution Early Release Survey (CEERS), we studied one candidate of galaxy-galaxy lensing. We first used GALFIT to create a model from the source image that was only the galaxy. We then used the model and source image to create a residual, which we used to do photometry. We measured the fluxes of the foreground (lensing) and background (lensed) galaxy, the latter of which appears as an arc in the image, in several infrared filters. We were then able to use these measurements to run SED fitting to learn the physical properties of the foreground galaxy and lensed galaxy.

9:30am **Ellie Gates** **University of Missouri - Columbia**

Studying Gravitational Lensing in the Early Universe with the James Webb Space Telescope: II. Modeling

Spectral Energy Distribution fitting is a technique that fits model galaxies to wavelength vs flux plots of astronomical objects, in this case one galaxy and its visible arc from the Cosmic Evolution Early Release Survey (CEERS) that we believed to be exhibiting gravitational lensing. The best-fit models for the galaxy and arc provide the distances and stellar masses of each object, among other properties. By comparing the distances between the two objects, we concluded that the arc is a more distant object being gravitationally lensed by the foreground galaxy. We used PyAutoLens to model the lensing system to understand its geometry. We used the known mass and redshift of the two objects in the system and will continue to work to figure out the foreground galaxy's dark matter distribution. This will allow us to more accurately model the system. We also detected several other candidates of gravitational lensing from the CEERS survey. We will measure the distributions of dark and ordinary matter in these galaxies. These results will give us insight into the formation and structure of these massive galaxies in the early universe.

9:45am **Juventud Luna** **University of Missouri - Kansas City**

Characterizing Response of the LuSEE-Night Spectrometer

The Lunar Surface Electromagnetics Experiment – Night (LuSEE-Night), is a radio telescope that will be stationed on the far side of the Moon in 2025 with the DOE charge currently being led by Brookhaven National Laboratory. LuSEE-Night will allow us to look closely at a period of time in the early age of the Universe, the Dark Ages, that is not possible on Earth due to its ionosphere. It is of importance to simulate any issues in intercepting these signals and find ways to remove them with filters without severely compromising the level of signal received. We have found that if there are corruptions to our data the power received is spread all over and badly affects the power in the 1 MHz – 50 MHz range. We have also characterized the spectrometer that will be on board and are currently constructing a function in the firmware to enable the bins to be "zoomed" in on. We are currently gaining more insight into the signal in this range of frequencies so we can precisely predict what to expect when LuSEE is operational. With our gained knowledge, LuSEE will be closer to launch and first light. Once in operation, LuSEE will be able to see things we have not been able to see before and is bound to lead us to new discoveries.

Session 4, Sat Nov 4

10:30am **Brandon Coleman** **University of Kansas**

Finding Rare AGN: Investigating the Evolution of Cold Quasars

The classic major merger scenario states that the most luminous quasars are formed through the coalescence of two gas-rich disk galaxies, in which a starburst phase precedes the unobscured quasar phase. Cold quasars break this picture as they are unobscured quasars yet have significant star formation. Our previous understanding of cold quasars is derived from a small sample size from the Stripe82X survey. I expand the sample using the North field from the XXL-XMM survey. I created a crossmatched catalog of 1005 X-ray luminous AGN with multiwavelength counterparts including photometry in all three Herschel SPIRE bands. Within the XXL sample, I observed 175 cold quasars, greatly expanding the original sample size from 30 observed in Stripe82X. I constructed spectral energy distributions (SED) for each source to estimate host galaxy properties including star formation rate, dust mass, stellar mass, and infrared luminosity. We also measure black hole masses from SDSS spectra. We find that: 1) most cold quasars have black hole masses that are significantly larger than would be expected from their stellar mass; 2) cold quasars predominantly lie well above the main sequence of star formation; and 3) cold quasars have elevated gas masses compared with normal unobscured quasars. Through examining the far-infrared emission and X-ray emission of cold quasars over cosmic time, I demonstrate that they do not fit into the standard picture of quasar evolution.

10:45am **Thresa Kelly** **University of Kansas**

A Multiwavelength Comparison of X-ray and Infrared Selected Active Galactic Nuclei

Active galactic nuclei emit energy across the entire electromagnetic spectrum. Using only one wavelength region to identify AGNs may miss sources with unique characteristics. In this work, we compare the multiwavelength properties of X-ray and infrared (IR) selected AGN in the COSMOS field for z < 6. Our X-ray-selected AGN sample includes all sources with a 0.5 - 10 keV X-ray luminosity greater than 10^{43} erg s^{-1}. We define our IR-selected AGN sample using the four Spitzer/IRAC channels. We find that both selection methods miss a significant fraction of AGNs that are identified using the competing method. X-ray AGN selection is able to capture the most diverse range of multiwavelength emission properties, but misses a fraction of heavily obscured AGNs. Meanwhile, IR AGN selection is generally biased towards more powerful, dusty AGNs.

11:00am **Kurt Hamblin** **University of Kansas**

Utilizing Probabilistic forecasting to identify AGN in JWST

Understanding the link between supermassive black hole growth and host galaxy evolution requires assessing not just high-luminosity active galactic nuclei (AGN), but also previously unseen low-luminosity AGN. The James Webb Space Telescope (JWST) pushes further down the AGN luminosity function than ever before, allowing the identification of elusive low-luminosity AGN. Existing AGN color selection methods make use of at most 4 photometric filters, but JWST/MIRI and JWST/NIRCam collectively have 19 broadband mid-infrared photometric filters, demonstrating a need for improved AGN selection methods that make use of all available information. Such improved methods are particularly needed for the identification of AGN in strongly star forming galaxies, known as composite galaxies, which can appear quite similar to typical star forming galaxies, and to identify heavily obscured AGN. I am developing a new tool for the identification of AGN in JWST/MIRI, utilizing XGBoostLSS, a probabilistic extension of the popular Extreme Gradient Boosting (XGBoost) algorithm.

11:15am **Mark Brodwin** **University of Missouri - Kansas City**

X-ray AGN in Dynamically Active Massive Galaxy Clusters at z ∼ 1

We present an analysis of the cluster X-ray morphology and active galactic nucleus (AGN) activity in nine $z \sim 1$ galaxy clusters from the Massive and Distant Clusters of WISE Survey (MaDCoWS) observed with Chandra. Using photon asymmetry (A_phot) to quantify X-ray morphologies, we find evidence that the four most dynamically disturbed clusters are likely to be mergers and that these these clusters host excess AGN compared to the local field. Our analysis finds evidence (at the $\sim 2.7\sigma$ level) of a positive correlation between AGN surface density and photon asymmetry, suggesting that a disturbed cluster environment plays a pivotal role in regulating AGN triggering. Studying AGN incidence in cluster X-ray isophotes equivalent in area to a $1.0\ r_{500}$ aperture, we find that the AGN space density inversely scales with cluster mass as $\sim M^{-1.69\pm0.85}$, consistent with AGN triggering via satellite-satellite merging. Finally, when we separately explore the cluster mass dependence of excess AGN surface density in disturbed and relaxed clusters, we see tentative evidence that the two morphologically distinct sub-populations exhibit diverging trends, especially near the outskirts, hinting that infall interactions may depend on cluster dynamical state.

11:30am **Gregory Troiani** **University of Kansas**

PRIMER: New Eyes on the Sky

We present new science images from PRIMER, the Public Release Imaging for Extragalactic Research survey. PRIMER is the first deep, large scale extragalactic survey performed by the James Webb Space Telescope, providing the largest available area of fully sampled JWST images. It utilizes both the Mid-Infrared Instrument (MIRI) and the Near-Infrared Camera (NIRCam) to give broadband photometry from 0.9 to 18 microns in the UDS and COSMOS fields. We also discuss ongoing efforts to construct a visual classification scheme for MIRI-selected PRIMER sources. The short-term goal of this project is to examine the theory of merger driven AGN growth by visually classifying mergers and extracting their AGN fractions through fitting of spectral energy distributions (SEDs). However, the visual classification infrastructure and scheme will have broader uses once complete and will be expanded to encompass all PRIMER sources. This will provide excellent opportunities for citizen science and outreach.

Session 5

2:15pm Lucia **Fisher & Timothy Rosno** **Benedictine College**

Photometric and Spectroscopic Study of the SRD variables V441 Her and UU Her

Semi-Regular Type d (SRd) variable stars are pulsating yellow supergiants in the transitional evolutionary phase following the asymptotic giant branch and preceding the white dwarf stage. Despite decades of research, these stars are not well understood. To gain new insight into this important phase in the life of low mass stars, a photometric and spectroscopic monitoring study of SRd variables has been underway at Benedictine College's Daglen Observatory since summer 2020, beginning with V441 Herculis, and adding UU Herculis in 2023. We will discuss the data obtained to date, with an emphasis on 2023. In contrast to studies of V441 Her over the past 3 decades, it no longer exhibits a well-defined pulsational cycle. V441 Her also shows evidence of irregular shocks and mass ejections, and may have begun its final transition to a white dwarf. Despite UU Her previously being regarded as the archtype of a class of high galactic latitude Semi Regular variables, no studies of UU Her have been published for over two decades. It exhibits irregular pulsational behavior that is not consistent with models typically used to describe pulsating yellow supergiants. Fourier analysis of archival photometric data indicates that UU Her's pulsational cycle either shut down or was obscured from 1990 – 2010, and our data may suggest that it now has a semi-detached circumstellar envelope.

2:30pm **Matthew Millard** **University of Iowa**

A Review of High-resolution X-ray Spectroscopic Studies of Type Ia Supernova Remnants

The remnant gas of Type Ia supernovae is generally enriched in thermonuclear fusion products - Si, S, Ar, Ca, and Fe - from the explosive unbinding of a white dwarf. As a supernova remnant (SNR) expands, the gas may become shock-heated, causing it to emit in X-rays. The X-ray spectra of shock-heated SNRs often reveal H- and He-like Kα triplet line emission from these elements, as well as a complex of L-shell emission lines from Fe. These individual lines are closely-spaced, and thus are indistinguishable to current medium-resolution CCD spectrometers. With high-resolution X-ray grating spectroscopy, it becomes possible to resolve these individual lines. Measurements of the individual line widths, shapes, and intensities provide crucial information about the physical characteristics of the emitting SNR plasma. Analysis of these properties plays a pivotal role in constraining models of the progenitor supernova explosion mechanism and 3D evolution of the SNR. I will review results from studies of Type Ia SNRs that take advantage of high-resolution X-ray spectra produced by grating spectrometers aboard the Chandra and XMM-Newton observatories.

2:45pm **Joseph Wandishin** **Benedictine College**

Ozone Reactions Occurring in the Interiors of Protoplanetary Ice Grains

The study of chemical reactions which occur on the dust grains and protoplanetary discs has become crucial to understanding the formation of interstellar complex organic molecules, such as amino acids and polycyclic aromatic hydrocarbons. Despite this focus, however, much of the work has focused only on the surface reactions, leaving the mantle reactions poorly researched. Only in the past decade or so have strides been taken to better understand the complexity of these reactions within the ice. In this talk, I will present an overview of recent work to more accurately simulate solid-phase chemical reactions in cosmic ice. Such improved models will be critical tools for analyzing James Webb Space Telescope data and planning observations.

3:00pm **Harry O'Mara** **University of Arkansas**

MiSaTaQuWa Equations in a Plane Wave Spacetime

The gravitational radiation reaction problem, in the self force approach, can be said to begin with what are now called the MiSaTaQuWa equations named after the five relativists who first derived the equations at the end of the twentieth century. The MiSaTaQuWa equations describe a correction to geodesic motion in a background spacetime to first order in mass as a result of the object in question interacting with the gravitational waves which it itself generates. Plane wave spacetimes are known to function as exact solutions to the Einstein equation and are chiefly useful for understanding the mechanics of gravitational waves themselves as plane wave spacetimes are limited physically. In this presentation we give an overview of the Green's function method often used to derive the MiSaTaQuWa equations and apply this Green's function decomposition to a number of simple flat spacetime examples showing their utility in scalar and electro-magnetic cases. We then reduce the MiSaTaQuWa equations, in a self-consistent manner, into a closed form in a plane wave background and give a description of the application of the MiSaTaQuWa equations in gravitational self force calculations. The Penrose limit provides a context in which our results may offer a direct contribution to the focus of the current gravitational radiation reaction research. It can be shown that plane waves can serve as a limit to all spacetimes in the neighborhood of null geodesics. Further investigation could reveal whether the MiSaTaQuWa equations in Schwarzschild and Kerr spacetimes extrapolate in a parallel manner to the equations developed here in the kind of ultra-relativistic limit described by Penrose. The approach followed in this presentation of modeling gravitational fields by a plane wave spacetime could also prove beneficial for the study of both classical and quantum fields in curved backgrounds.

3:15pm **Joel Berrier** **University of Nebraska – Kearney**

A Technique to Estimate LISA Signal Confusion Noise

Due to scattering events, stellar-mass compact objects will occasionally end up in highly eccentric orbits around Supermassive Black Holes (SMBH) and will produce gravitational waves. With such long period orbits, they emit gravitational waves so rarely that individual events are not likely to be detectable, however, an ensemble of such events will produce a background noise that may hide otherwise detectable sources with the planned space-based gravitational wave detector, LISA. We model the SMBH population using the Illustris simulation to create the black hole mass function from $z=0-3$ and estimate the number of expected unresolvable events that will contribute to this background noise over that same redshift range. These factors will be combined with models of the distribution of orbital parameters and a catalog of waveforms to estimate this signal confusion noise.

3:30pm **Andrii Dzygunenko** **Andover Central High School**

Period Analysis of 3 Eclipsing Binary Stars with TESS Data

We present our research based on the processing of photometric data from the TESS space telescope of three eclipsing binary systems: TIC 199716496, TIC 414764074, and TIC 435447013. Based on this data, we determined the types of these binary variable stars. Among them there were two unclassified stars and one with previous incorrect classification. We discovered variability of TIC 414764074 and TIC 435447013 and classified them as EW and EA types; classification of TIC 199716496 was corrected from EB type Algol to EA type. Moreover we completed period analysis for each star which includes: calculation the period and initial epoch, plotting and studying of O-C curves & periodograms. The main part of our research was the calculation and plotting of O-C curves. The light curve of each star was divided into separate minima and maxima using a Python program called "splitter" version 2.6. The separated data sets were then processed using MAVKA software. MAVKA is the software that allows us to calculate the moments of extrema and their magnitude using various approximations. For minima, we used a symmetric polynomial approximation. Simple polynomial approximation was used for maxima. By analyzing the shape and behavior of the O-C curve, we can gain insight into the dynamics and evolution of binary star systems, and the processes that govern their behavior.

Session 6

4:15pm **Bret Lehmer** **University of Arkansas**

X-ray Binary Population Luminosity Functions in Galaxies and their Dependence on Star-Formation History and Metallicity

The formation of X-ray binary (XRB) populations in galaxies has long been understood to be sensitive to both galaxy star-formation history (SFH) and metallicity; however, the details of this relationship has not yet been clearly quantified. We will present a new empirical framework modeling the SFH and metallicity dependence of XRB population luminosity functions (XLFs) that self-consistently describes XRB populations over the full range of galaxy types. We test our model framework using ~2000 X-ray detected point-sources within 44 Chandra-observed galaxies at D < 30 Mpc that span a broad range of metallicity and SFH (spanning early-to-late type morphologies). Our models provide unifying quantitative context for scaling relations that have been well studied in the literature, including, e.g., the high-mass XRB (HMXB) luminosity versus SFR relation (LX(HMXB)/SFR), the LX(HMXB)-SFR-metallicity plane, the ultraluminous X-ray source frequency as a function of metallicity and age, the low-mass XRB (LMXB) luminosity scaling with stellar mass (LX(LMXB)/M*), and the observed evolution of LX(HMXB)/SFR and LX(LMXB)/M* relations with cosmic time. We will discuss how these relationships serve important roles in a variety of Astrophysical studies beyond XRB populations (e.g., AGN, gravitational wave sources, cosmological studies of the early Universe, ISM ionization, and population synthesis models).

4:30pm **Byron Morales Maldonado** **University of Kansas**

Environmental Effects on the Gas Contents of GOGREEN Passive Galaxies

The effects of the environment on the gas content of passive galaxies in higher redshifts are investigated. To achieve this, spectroscopy of galaxies in clusters at $1 < z < 1.5$ from the Gemini Observations of Galaxies in Rich Early Environments Survey (GOGREEN survey) were used. The gas content of galaxies was probed by measuring the 3727 Å [OII] emission line in the galaxy spectra. The [OII] emission results from collisional excitations of Oxygen with photoelectrons in excited nebular gas. From the survey, a sample of 342 galaxies from 11 clusters with good spectroscopic quality, and masses greater than $10^{10.2}$ solar masses were selected for analysis. These galaxies were later classified in the field or as cluster members based on their position in position-velocity space. Additionally, the sample was subdivided into star forming (SF), quiescent (Q), green valley (GV), blue quiescent (BQ) and post starburst (PSB) populations based on their positions in (NUV-V)(V-J) and (U-V)(V-J) color space. 10 groups resulted based on the population and environment classification. The relative strength of the [OII] emission was measured by fitting the spectra's continuum to a lineal model and the emission to a gaussian model, and calculating the equivalent width (EW) of the spectral line. This measurement was done to each individual spectra and to the stacked spectra of each group. From these measurements significant detections were found for both SF environments and GV field, while no significant detections were found for the rest of the groups. In general, the field presents higher [OII] emissions than the cluster members. These same trends are observed in the emission fractions of the groups.

4:45pm **Adriana Feener-Rivera & Jennifer Vanderslice** **University of Missouri - Kansas City**

MaDCoWS II: A First Look at a New, High-z Galaxy Cluster Survey

The original Massive and Distant Clusters of WISE Survey (MaDCoWS) combined infrared data from the WISE telescope with ground-based optical data from Pan-STARRS to discovery stellar mass-selected galaxy clusters at $z \sim 1$. With the emergence of much deeper Legacy Survey optical data set, along with deeper WISE imaging from the ongoing NEOWISE mission, we have been undertaking the successor MaDCoWS II survey which is capable of tomographically detecting galaxy clusters from 0 < z < 2 and beyond. In this talk we will highlight some of the interesting systems discovered to date within the footprint of the Hyper Suprime-Cam Subaru Strategic Survey (HSC). These include both strong lensing and bullet cluster-like systems that powerfully probe the nature of dark matter.

5:00pm **Joseph Huber** **University of Missouri - Kansas City**

An X-ray Probe of High-redshift Galaxy Clusters in the MaDCoWS Surveys

The high-redshift galaxy clusters detected by the Massive and Distant Clusters of WISE Survey (MaDCoWS) are prime candidates for investigating cluster evolution over cosmic time. More detailed pictures of their evolution can be revealed through their galactic properties. This study aims to conduct an archival search with Chandra and XMM-Newton data on the MaDCoWS 1 and 2 catalogs, with the goal of exploring the triggering of Active Galactic Nuclei (AGN) in dense environments. Using X-ray imagery, we can identify point sources and AGN along the line of sight, allowing us to probe cluster evolution and morphology. Preliminary results will be shown and discussed in this presentation.

5:15pm **Rachel Cionitti** **University of Missouri - Kansas City**

Passive Fractions of Massive and Distant Clusters of WISE (MaDCoWS) Member Galaxies

The high-redshift galaxy clusters detected by the Massive and Distant Clusters of WISE Survey (MaDCoWS) are prime candidates for investigating cluster evolution over cosmic time. More detailed pictures of their evolution can be revealed through their galaxy properties. In this project, galaxies from various surveys in the Boötes field are assigned as 'members' to previously identified MaDCoWS clusters, using redshift information of both the galaxy and the cluster. Once a galaxy's membership within a cluster is deemed probable, one is allowed a much richer picture of the properties of the cluster itself. Here we investigate cluster properties using the proxy of the quiescent fraction of their identified member galaxies. This is achieved through the use of UVJ diagrams. Preliminary results of these diagrams will be shown and discussed in this presentation.

Posters

Amirnezam Amiri **University of Arkansas**

Gas-Phase metallicity measurement of the Seyfert galaxy NGC-7130

The purpose of this work is to measure gas-phase metallicity for disc, broad and narrow components of NGC 7130, a Seyfert Type II galaxy. To measure radial gas-phase metallicity for each component, we utilized both Active galactic nuclei (AGN) and Star-forming (SF) strong line abundance estimator, by using BPT diagnostic diagram. We measured metallicities using relations involving with sensitive strong emission lines, [OIII] 5007, [NII] 6584 Å, Hα, Hβ, [SII] 6716Å and [SII] 6716 Å, observed with the Multi Unit Spectroscopic Explorer (MUSE) at the Very Large Telescope (VLT), as published by (Comerón et al. 2021). We find a dual behavior for the radial gas-phase metallicity of AGN parts that It may show external phenomena impact the variations of the radial gas-phase metallicity.

Michael Bandemer **University of Arkansas**

Generating Realistic Synthetic X-ray Binary Population Luminosity Functions with POSYDON

Observations of low-metallicity and high-redshift galaxies (e.g., with HST and JWST) have shown that current models of stellar populations cannot reproduce important high ionization emission lines without adding new sources of ionizing photons. One promising avenue for resolving this issue is the incorporation of interacting binary systems, like X-ray binaries (XRBs), which provide ionizing photons beyond that typically modeled from stars. However, detailed models describing XRB population evolution are still highly uncertain. Recent studies have begun to explore how varying physical assumptions in binary population synthesis models impact synthetic X-ray luminosity functions (XLFs) and how these XLFs compare with observational constraints. In Misra et al. (2023), XLFs were generated with the POpulation SYnthesis with Detailed binary-evolution simulatiONs code (POSYDON, Fragos et al. 2023). The XLFs were varied by creating populations of XRBs dominated by high-mass X-ray binaries (HMXBs) that made varying assumptions about parameters related to physical properties, such as the evolution of Common Envelope, Supernova natal kick normalization, and wind-fed accretion. None of the models generated fit the observed XLF data from Lehmer et al. (2019) well, suggesting that additional assumptions about the populations must be varied, e.g., assumptions about the distributions of orbital periods and eccentricity, distribution of mass ratios, and metallicity of the systems. This study will explore the effect of varying population characteristics of XRBs using POSYDON to generate XLFs to then compare with observed XLFs to further constrain our understanding of these characteristics of binary stellar systems.

Benjamin Bogner **University of Arkansas**

Timing Trends in the Calculation of Moderate Eccentricity EMRI Gravitational Waves

Compact objects on highly eccentric orbits around galactic central supermassive black holes produce gravitational waves. The gravitational waves from these Extreme Mass Ratio Inspiral (EMRI) orbits will be a prominent source of signal confusion noise for the space-based gravitational wave detector LISA. Understanding the precise form of these waves is necessary for disentangling background noise to increase sensitivity in relevant LISA operating frequency bandwidths. The power outputted by the source system is dependent on the peak harmonic modes of the characteristic gravitational wave spectrum. However, calculating the power outputted by highly eccentric EMRI systems is computationally expensive. Instead of serially searching each mode, predicting the location of peak harmonic modes will provide a way to reduce computation time. Steps have been taken to characterize and reduce the computation time of EMRI gravitational waves at moderate eccentricities, which will allow for prediction of the peak harmonic modes at higher eccentricities.

Craig Brooks **University of Kansas**

Multiwavelength deconvolution of cluster galaxies at redshift $z \sim 1.3$

In order to understand the mechanisms of quenching in environments such as clusters, it is necessary to probe the local structure and spatially resolved colors of individual galaxies. The difficulty arises in that the imaging data from ground-based surveys has insufficient resolution to accomplish this. In order to circumvent this problem, we are using a multi-wavelength deconvolution algorithm implemented by the STARRED package to significantly improve the image quality at rest-frame UV through near IR for cluster and field galaxies at $1 < z < 1.5$ from the GOGREEN survey. By using STARRED, the spatial resolution of images can be enhanced potentially up to .3", close to the resolution of HST. I will discuss early results using STARRED on GOGREEN.

Keaton Donaghue **University of Kansas**

Optical Depth and Temperature of Dust Surrounding Massive Clusters in NGC 253

We present the first high-resolution (0.1'') ALMA Band 9 (690 GHz continuum) data of the embedded star clusters in the nearby galaxy (D=3.5 Mpc) NGC 253. As the nearest example of a nuclear starburst, NGC 253 is a prime candidate to study super star cluster (SSC) formation and to catch extreme star formation in the act. This kind of star formation is considered a modern analog to star formation in the epoch of galaxy formation. Previous work has identified 14 primary super star clusters embedded in the central 200 pc which follow-up work has resolved into 33 individual subclusters. Prior work has also shown that these clusters are in the proto-SSC to early SSC stages of development. With Band 9 we refine the measurements of the dust optical depth and peak temperature of the SSCs. Early results find dust optical depth ranging from 0.06-0.6 which is within the expected 2-4 times increase from the optical depths previously measured with ALMA Band 7 (350 GHz). We also find SSC peak temperature ranges for the SSCs ranging from 16-92K. With these measurements, we can then constrain the lower limits of the dust temperature and dramatically improve the gas and dust mass estimates of the clusters.

Madeleine Del Endecott **University of Kansas**

Observation and Data Refinement of Young Open Clusters as Tracers of Galactic Environment

Understanding the environment of the outer Milky Way can assist in the study of other galaxies by providing a standard model for comparison. We can measure how the galactic environment affects star and star cluster formation by observing astrophysical parameters such as metallicity, distance, and apparent magnitude of young open clusters and the stars within them. Over the summer of 2023, we used the Lowell Discovery Telescope to take images and spectrographs of young open clusters and cluster members in the Perseus and Outer Arms. We matched our data for observed stars in each cluster with measurements from GAIA DR3 and overplotted the GAIA data onto an image of the cluster to create a visual representation of the clusters' structures, with each possible cluster member color-coded by its distance from Earth. We fit the spectrographs of cluster members to synthetic spectra and estimated the effective temperature, metallicity, and surface gravity for each star of interest. These observations will allow us to calculate the amount of dust causing interstellar reddening and extinction along the line of sight to each cluster and, in the future, begin constructing a map of galactic environments across the Milky Way. This project was made possible by the NSF REU award (#1950901).

Donovan Flagg **University of Missouri - Columbia**

Measuring the Pitch Angle of High Redshift Galaxies

The James Webb Space Telescope (JWST) has supplied scientists with a cascade of opportunities to further our understanding of the universe. The Cosmic Evolution Early Release Science Survey (CEERS) has released images taken by JWST of high redshift galaxies for researchers to analyze. The composition of galaxies and their exact morphologies is an imperative subject of study in astronomy. Analyzing spiral galaxy arms can provide useful information on the mass of the central black hole and the influence of dark matter, which makes up about 27% of the universe. Pitch angle is the measurement of how tightly woven a spiral galaxy's arms are in relation to its center. Using the new data released from the CEERS survey, we can measure the pitch angles of high redshift galaxies to expand our understanding of central black holes and dark matter distribution. Furthermore, use such results and compare them to closer, younger galaxies to improve our models of galaxy morphology/evolution.

Emerson Gehr **University of Arkansas**

Modeling Spectra of X-Ray Binaries Across Galaxy Types

X-ray binaries (XRBs) are the most luminous sources of X-ray radiation in normal late-type galaxies that do not have active galactic nuclei. We can categorize XRBs broadly into high mass XRBs (HMXB) and low mass XRBs (LMXBs), the emission of which scales with star formation rate (SFR) and stellar mass, respectively. Recent work has also found that HMXB emission is sensitive to the metallicity of the host stellar populations, such that low metallicity galaxies harbor more luminous HMXBs than high metallicity galaxies for a given SFR. Incorporating these findings, we are now in the process of constructing models that characterize how the X-ray spectral energy distributions (SEDs) vary with galaxy properties like metallicity, SFR, and stellar mass. We make use of Sherpa to construct physical models of our XRBs, incorporating how accretion disk, Comptonization, and absorption vary with XRB luminosity and how the contributions of various XRB subclasses vary across galaxy populations. In the long term, we aim to produce new realistic X-ray spectral models that can be incorporated into SED fitting codes, including, e.g., CIGALE and LIGHTNING, that will enable X-ray data to aid in constraining galaxy properties.

Don Hilary Sanjaya Hettiarachchi **University of Arkansas**

Theoretical Study of Density Wave Theory and a Consistent Set of Scaling Relations for Spiral Galaxies with Inner and Outer Arm Structures.

We studied the galactic spiral arm pitch angle dependence with wavelength as predicted by the density wave theory. A sample of 10 barred and unbarred spiral galaxies with two distinct arms was used for the measurements. Our data sample consisted of galaxies with inner arms and galaxies with both inner and outer arms. We used IRAF and published deprojection parameters available on NED/ HyperLeda databases to deproject the original images to face-on orientation. Firstly, the pitch angles were visually measured with a Python-based script. We then measured a pitch angle range using six wavebands, namely 3.6 μm, 8 μm, B-band, Ha, HI, and CO wavebands based on the availability of data. Pitch angles were measured for each spiral arm separately using SPIRALITY, a MATLAB-based script. We found a 1:1 correlation between pitch angle measurements in the 3.6 μm and 8 μm bands. Central supermassive black hole (SMBH) masses were predicted for 3.6 μm waveband pitch angles using a standard scaling relation. We obtained black hole masses of galaxies with both inner and outer arms using the pitch angles of each inner arms and outer arms separately. We found that the black hole mass of a galaxy with both inner and outer arms is determined by the average pitch angle of the inner arms. In $\log(M_{BH}/M_{\odot})$ units, NGC 7479 had the highest black hole mass of 7.552 ± 0.187, and NGC 5248 had the lowest of 6.317 ± 0.319. Using only galaxies with inner arms, we found an SMBH mass-pitch angle relation of $\log(M_{BH}/M_{\odot})$ = (7.11 ± 0.33) + (0.003 ± 0.017) P. Using only galaxies with both inner and outer arms, we found an SMBH mass-pitch angle relation of $\log(M_{BH}/M_{\odot})$ = (7.56 ± 0.28)- (0.038 ± 0.013) P. We calculated the dark matter content of the galaxies using a standard scaling relation with 3.6 µm waveband pitch angles. We obtained dark matter halo masses for galaxies with both inner and outer arms using the pitch angles of each inner arms and outer arms separately. In $\log(M_{BH}/M_{\odot})$ units, NGC 7479 had the highest dark matter halo mass of 12.134 ± 0.301, and NGC 5248 showed the lowest of 11.296 ± 0.996. Using only galaxies with inner arms, we found an SMBH mass-dark matter halo mass relation of $\log(M_{BH}/M_{\odot})$ = (1.48 ± 0.03) $\log(M_{DM}/M_{\odot})$ - (10.46 ± 0.31). Using only galaxies with both inner and outer arms, we found an SMBH mass-dark matter halo mass relation of $\log(M_{BH}/M_{\odot})$ = (1.44 ± 0.03) $\log(M_{DM}/M_{\odot})$ - (10.01 ± 0.38).

Duy Huynh **University of Kansas**

Adding Archival Herschel Space Observatory Data to Complement the Virgo Filament Survey

The Virgo Filament Survey (VFS) is a collection of galaxies that are within and around the Virgo Cluster. This survey, made from a highly curated combination of many other surveys and databases (HyperLeda, NED, etc), provides us a list of over 6000 near-Virgo Cluster galaxies and their observed characteristics. The data on the galaxies includes WISE in the 3.4, 4.6, 12, and 22 μm wavelength bands. Most have data from observations with the GALEX Satellite, and a small subset have measurements of the HI and CO bands. Furthermore, the VFS team conducted a H-alpha imaging survey of the galaxies with CO observations. One thing that is missing, however, is the far infrared observation of these galaxies. This can help complement the 12 and 22 μm WISE data to further map the obscured star formation rate within these galaxies. The Herschel Space Observatory was equipped with instruments to observe specifically in these wavelengths. As such, while the telescope has long been decommissioned, we can still use the available archival data from past observations to further quantify the amount of obscured star formation in our galaxies and its spatial location within the galaxies.

Madison Norwood **University of Arkansas**

New X-ray Spectral Constraints for Luminous Infrared Galaxies: A Case Study of NGC 3221

X-ray studies of nearby star-forming galaxies have constrained a relationship between their X-ray luminosities and galaxy star-formation rates (SFRs); hereafter, the LX-SFR relation. However, the most extreme nearby star-forming galaxies, luminous infrared galaxies (LIRGs), appear to often be under luminous compared to their predicted LX values from the LX-SFR relations. Suggestions for the deficit of X-ray emission from LIRGs have been proposed, including large intrinsic absorption, high metallicities, and very young stellar ages. Using X-ray data from the Chandra observatory and galaxy properties derived from the HECATE catalog, we are studying the X-ray spectral properties of ~100 LIRGs to test some of these suggestions and separate hot gas and X-ray binary (XRB) contributions that dominate LIRG X-ray emission. We present here a first integrated study of the astrophysical X-ray emissions from the LIRG NGC3221, in which we demonstrate techniques to disentangle hot gas and XRB emission. Our methods challenge the universal assumption of using a single spectral shape of an absorbed power-law for XRBs and provide new estimates of LX values associated with hot gas and XRBs and their respective correlations with galaxy properties. Our work will provide new insights into addressing why LIRGs are often deficient in observed X-ray emission and the connection between hot gas and XRBs and host galaxy properties (e.g., star-formation history, metallicity, etc.).

Ryder Smith **University of Arkansas**

Spectral Modeling of Star-Forming Regions in M83: Insights into the Interstellar Medium

The low-energy (< 1 keV) emission from normal galaxies is observed to be dominated by diffuse emission associated with a hot phase of the interstellar medium (ISM). This hot gas is predicted to arise due to feedback from young stellar winds and supernovae, which entrain and heat ISM material. Using >800 ks of Chandra observations of the nearby star-forming galaxy M83, we are undertaking a detailed spectral analysis of a variety of regions across the galaxy. We are investigating whether local gas properties, like absorption and hot-gas temperature and luminosity, correlate with star-formation rate (SFR) on sub-galactic scales. Such correlations are expected from models of the hot ISM, but have yet to be assessed on local scales within galaxies. Our work will provide a test of such models and a deeper understanding of the hot ISM in star-forming galaxies.

Zachary Wilson **University of Arkansas**

Using X-ray Colors to Quantify Spectral Diversity of X-ray Binary Populations in M83

In normal galaxies, such as M83, hot gas and X-ray binaries (XRBs) dominate the X-ray emission spectrum. Thanks to high spatial resolution imaging with the Chandra X-ray Observatory, we are able to separate these emission components spatially and analyze the contributions to the galaxy-wide spectrum from XRB point-sources directly. Using Sherpa, an X-ray spectral modeling tool, we are generating grid spaces of XRB models that include intrinsic absorption and physical models of accretion disk and Comptonization emission. Our goal is to use X-ray color information from Chandra-detected sources in M83, along with our model grids, to identify XRB physical models that are consistent with the data. We will then sum these models to build a galaxy-wide X-ray spectral model for XRBs in M83. We will discuss our procedure for constructing these models and using color information to constrain physical parameters of the XRBs.

Parker Wise **University of Kansas**

Measuring Accurate Masses in a Protocluster Source in the Galactic Center

We present a millimeter spectral analysis of a star forming region near the Galactic center in the Central Molecular Zone (CMZ). Source “c” (G0.380+0.050), located in the dust ridge, is a cloud that, for its concentrated mass (~1000 solar masses within a radius of < 1 pc), should be star forming at a much higher rate. We observed the J=1-0 transitions of the CO isotopologues,12C16O, 12C18O, 12C17O, 13C16O, as a part of a larger survey of 30 positions in the CMZ, using ALMA band 3 with an angular resolution of 2” (0.08 pc). Our goal is to characterize the masses of individual substructures in this proto cluster. By observing multiple CO isotopologues and gas phase temperature tracers our goal is to establish more accurate masses for the substructures than can be determined by the dust continuum alone as it suffers from a fundamental uncertainty on the dust temperature. The CO column densities that we measure will also be valuable for establishing absolute abundances for chemical studies of this source using data from the ALMA Large program ACES (ALMA Central Molecular Zone Exploration Survey).