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Book of Abstracts

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Talks

01 - Talk: The BEARD survey: A multi-facility survey of Milky-Way analogs

Jairo Mendez Abreu

Universidad de La Laguna

In a λCDM Universe the growth of galaxies is expected to happen hierarchically: mergers of small systems eventually create a giant galaxy. This theory seems to work well for massive ellipticals, but the stellar discs of massive spirals, such as our own Milky Way, are fragile systems that may not survive a violent merger. Therefore, the question arises: how are discy giants built? In this talk I will present the BEARD (Bulge Evolution And the Rise of Discs) project, a multidisciplinary collaboration to robustly address whether massive bulgeless galaxies (like our MW) represent a challenge to the ΛCDM paradigm. BEARD combines a multi-facility observational survey of a volume-limited sample of 66 MW-like galaxies with a well matched sample of galaxies obtained from cosmological simulations. We use different observational tracers to unveil the past merger history and mass growth of MW analogues. They include amongst others: i) the identification of merger-built bulges at the galaxy centres (integral-field spectroscopy — MEGARA@GTC, WEAVE@WHT); ii) the detection of faint stellar structures in the galaxies' outskirts (deep broad-band imaging — WFC@INT); or iii) the identification of distinct abundance patterns in galaxy discs (long-slit spectroscopy — DOLORES@TNG, ISIS@WHT; narrow-band Hα imaging — IO:O@LT). I will describe the status of the project and our first results which are already revealing a bimodality in the pathway followed by MW-like galaxies throughout cosmic history.

02 - Talk: Mergers and Disc Galaxies: Results from the BEARD Survey and TNG50 Simulations

Carlos Marrero de la Rosa

Instituto de Astrofísica de Canarias

The ΛCDM model predicts that mergers are expected to dominate the early evolution of galaxies. However, the high fraction of massive galaxies that are pure discs or that host very small bulges, including systems like the Milky Way (MW), challenges this paradigm. The BEARD (Bulgeless Evolution And the Rise of Discs) project is an international effort to provide multi-facility observational constraints to demonstrate the success or failure of the hierarchical ΛCDM scenario at forming MW analogs. In this talk, I will present our preliminary results from the analysis of deep photometry images of ~20 BEARD galaxies observed with the Wide Field Camera (WFC) on the Isaac Newton Telescope (INT). The data allows us to reach surface brightness depths ranging from 28 mag/arcsec2 to 31 mag/arcsec2. Such depth allows us to explore faint features that are crucial for understanding the merger history and mass assembly of these galaxies, while allowing for an adequate characterisation of their edges. The analysis employs advanced techniques, including the construction of the extended INT PSF, precise removal of scattered light from foreground stars, and robust 2D deconvolution of the images. By comparing the observational results with predictions from the Illustris TNG50 simulations, we are envisioning a scenario in which the amount and kind of mergers are crucial to create galaxies like our own, thus refining our knowledge on the hierarchical assembly of late-type galaxies.

03 - Talk: Higher Order Moment H4: Measuring the In-Situ Fractions of Galaxies through Kinematics

Rhea-Silvia Remus

University Observatory Munich, LMU

It is known that galaxies grow through a complex mixture of gas accretion, star formation, feedback, and merger events, and that the balance of the different channels determines the present-day properties of galaxies. While, with modern observational techniques, we can measure the formation times of stars from their ages and metallicities in the different galaxy components, it is extremely difficult to infer how much of the stellar content was made inside the galaxy, that is in-situ, and how much of it was accreted. Using the Magneticum Pathfinder ultra-high resolution simulations, I will show that this quantity can be calculated from measurements of the fourth order moment of the kinematics in an unprecedented precision, and demonstrate that this can be successfully applied to observations. Moreover, I will explain why this connection is naturally following from the accretion processes, and discuss how this can be used to disentangle the signatures from metallicities, ages, and velocities to assess the formation pathway of an individual galaxy, and how this is connected to the cycles of quenching and rejuvenation that galaxies go through — especially in their early formation phases. Finally, I will present first results from the successors of the Magneticum simulations, showing how bar formation is connected to the in-situ properties of galaxies.

04 - Talk: The BANG Survey: Bulge Assembly in Nearby Galaxies

Dimitri Gadotti

Durham University

The centres of disc galaxies hold evidence of the processes that shaped them. While disruptive events such as mergers can build dispersion-dominated classical bulges, bar-driven, secular evolution often triggers the formation of rotation-dominated nuclear discs. Therefore, the frequency and stellar mass distribution of these components can constrain the relative importance of internal and external evolution in disc galaxies. To date, observational results remain elusive: photometric studies are prone to large uncertainties and spectroscopic surveys either lack complete samples or spatial resolution. In this talk, we will present new results from employing state-of-the-art data from the MUSE integral-field spectrograph in a sample of 50 disc galaxies in the volume within 40 Mpc. We will present a detailed analysis combining stellar kinematics, stellar population properties and structural analysis to unambiguously determine the abundance of classical bulges and nuclear discs, and characterise their ages and chemo-dynamical properties. We find that the fraction of nuclear discs in barred galaxies is in the range between ~80% and ~90%, whereas only ~12% to ~17% of the nuclear discs are in unbarred galaxies. In addition, our initial results show that only ~17% to ~34% of the 50 galaxies do not host nuclear discs. These results will provide a basis for testing our models of galaxy formation and evolution in cosmological simulations.

05 - Talk: The Co-Evolution of Central Gas Rings and Nuclear Stellar Discs

Justus Neumann

MPIA

Nuclear stellar discs have long stayed hidden within the more ambiguous family of (pseudo-)bulges. Only recently they have gotten more attention thanks to high quality observations with the MUSE instrument and they might be much more numerous than we previously thought. At the same time, central gas rings or central molecular zones have been known and investigated for a long time but observational evidence for a direct connection to the stellar component has been scarce. In the project presented in this talk, we use MUSE observations in combination with JWST, HST and ALMA from the PHANGS survey to show that the existence of central gas rings and nuclear stellar discs is directly correlated. The near-perfect match in size between central gas rings and stellar discs across a sample covering bars in different evolutionary stages demonstrate that central gas rings are the outer edge within which nuclear stellar discs are formed. Negative age gradients suggest a co-evolution with an inside-out growing scenario. Only the powerful synergy between these observing facilities made it possible to showcase such clear evidence for this connection.

06 - Talk: Bar ages derived for the first time in nearby galaxies: Insights on secular evolution from TIMER

Camila de Sá Freitas

ESO

The epoch in which galactic discs settle and secular evolution starts is a major benchmark to test galaxy formation and evolution models. Yet, this epoch is still largely unknown. Once galaxies settle their discs and become self-gravitating, stellar bars can form, driving the subsequent evolution of their host galaxy. Determining the ages of bars can, therefore, shed light on the epoch of the onset of secular evolution. Nevertheless, until recently, timing when bars have formed has been challenging. In this talk, I will present the results of the first broadly applicable methodology to derive bar ages from a sample of 20 nearby galaxies. The method is based on the co-eval build-up of nuclear structures and bars, using integral field spectroscopic data from MUSE/VLT. We derive independent star formation histories of the nuclear discs by removing the background population. This allows us to time its formation epoch and, thus, the bar. We estimate the bar formation epoch of nearby galaxies from the TIMER survey, creating the largest sample of galaxies with known bar ages to date. We find bar formation epochs varying between 1 and 13 Gyrs ago, illustrating how disc-settling and bar formation are ongoing processes that first took place in an early Universe. We infer the bar fraction over cosmological time within our sample, finding remarkable agreement with the observed bar. We will also derive results on secular evolution processes such as quenching, bar evolution, and downsizing

07 - Talk: Spatially resolved stellar populations of thick disks: insights from the GECKOS survey

Francesca Pinna

Instituto de Astrofísica de Canarias

Recent JWST high-redshift observations have shown that galaxies initially formed their thicker stellar disk components. Their properties already exhibited diversity, seeding the wide variety of properties observed in the local universe. Integral-field spectroscopy (IFS) studies have revealed diverse stellar populations in nearby thick disks of different types of galaxies, suggesting that they result from different galaxy evolution paths. However, deep IFS studies of edge-on galaxies have been limited so far, and only larger samples can unveil the driving factors for this diversity. I will show here the stellar population analysis of a first subsample of thick and thin disks from the GECKOS survey, a MUSE large program targeting 35 nearby edge-on Milky Way-mass galaxies. These results reveal a clear trend of thick-disk properties with galaxy star-formation rates. Galaxies on the star-formation main sequence or below display old, metal-poor and alpha-enhanced thick disks, suggesting an early and fast formation. In contrast, highly star-forming galaxies have much in common with galaxies observed at high redshift, suggesting a much slower evolution. Their thick and thin disks are both relatively young and metal-poor, and show extended star-formation histories. Numerical simulations suggest that mergers play a key role in driving these differences, contributing not only accreted stars, but also large amounts of gas to extend off-plane star formation over time.

08 - Talk: Probing the Assembly Histories of Quenched Galaxies via Population-Orbit Superposition Method

Yuchen Ding

Liverpool John Moores Univerisity

We present a study of quenched galaxies using the population-orbit superposition method in the context of GECKOS—a VLT/MUSE large program targeting 35 nearby edge-on galaxies. GECKOS provides a unique sample of isolated quenched spirals, enabling us to investigate the internal mechanisms driving star formation shutdown in the absence of strong environmental influences. By fitting stellar kinematics, age/metallicity maps, we obtain stellar orbital distributions, which allow us to decompose each galaxy into cold, warm, and hot orbital components to trace their assembly histories. Our models reveal the detailed assembly history of quenched spirals, highlighting the role of internal processes. To contextualize these findings, we compare our results with quenched galaxies from the Fornax3D survey, which reside in a dense cluster environment. This comparison underscores the role of environment in shaping quenching pathways: isolated systems exhibit distinct signatures of secular evolution, while cluster galaxies show stronger environmental imprints. By integrating spatially-resolved MUSE data with dynamical models, we bridge the gap between small-scale processes and global galaxy properties. This approach provides new insights into the baryon cycle and the relative contributions of in-situ versus ex-situ processes in galaxy assembly, aligning with the conference's focus on resolved galaxy evolution.

09 - Talk: The GECKOS Survey: Classifying kinematic structures in edge-on galaxies through JAM modelling

Tomas Rutherford

ESO

In this talk, I will present early results from the GECKOS survey in a study that aims to create robust classifications of disc galaxy central kinematic components. We build on the stellar kinematic Gauss-Hermite velocity maps as tracers of galactic central structure by creating axisymmetric Jeans Anisotropic MGE (JAM) models for the available GECKOS sample. While components such as “bulges” and nuclear discs may be included in JAM with careful treatment of the surface brightness and mass gaussians, the array of possible stellar bar structure in disc galaxies is non-axisymmetric and fundamentally cannot be captured by a JAM model. By subtracting these models from the highly spatially resolved input velocity fields provided by MUSE, we disentangle, classify, and gain deeper understanding of the central structures from the residuals. Further, we combine our kinematic results with available photometric evidence to estimate the size of the bars we detect. Beyond bars, we see a wide range of residual structures. Taking these structures in combination with high-order Gauss-Hermite moments we search for, but find no evidence of classical bulges in the sample analysed so far. We conclude that Milky Way-like galaxies host a wide array of central kinematic components, and the high dispersion often seen in the centre of these galaxies is not necessarily indicative of a simple classical bulge.

10 - Talk: Modelling edge-on barred galaxies through a population-orbit superposition method

Yunpeng Jin

Westlake University

Barred galaxies are an important branch of the Hubble sequence. In the past decades, significant efforts have been made to understanding the formation and evolution of barred galaxies. We develop a population-orbit superposition method, which can fully utilize stellar kinematics and stellar populations obtained from MUSE-like IFS data, to construct 3D models of edge-on barred galaxies. This method can: (1) recover the pattern speed of edge-on barred galaxies; (2) decompose galaxy structures (e.g. bulge/bar/disk/halo) based on stellar orbits; (3) recover the stellar populations of different structures. We validate this method using simulated galaxies from the Auriga simulations, and confirm its reliability for application to edge-on barred galaxies in real observations (e.g. the GECKOS survey). By linking dynamics and stellar populations, our work provides new tools for understanding the formation and evolution of barred galaxies.

11 - Talk: Disentangling galaxy and dust evolution mechanisms through chemical abundances

Stefan van der Giessen

Ghent University & University of Granada

It remains an unanswered question what dictates the amount of dust in the interstellar medium. Asymptotic giant branch stars and supernovae are the stellar sources both in terms of production through dredge up or supernova explosions, but they also destroy dust during the star-formation and with supernova shockwaves. This lead to theories of efficient metal accretion in the interstellar medium onto dust grains. This implies that amount of dust in a galaxy is directly linked to the star formation history and how much material can interact with it. We can potentially disentangle the evolution effects by adding information on the chemical abundances of several elements. Oxygen primarily forms in high-mass stars, whereas nitrogen can form in low and intermediate-mass stars. Oxygen is also commonly suggested to accrete more efficiently onto dust grains. The goal of the talk is to combine our knowledge of metal and dust production to answer what drives the dust content in galaxies. The talk will showcase spatially resolved maps of the stellar mass, gas mass, and dust mass surface density for local spiral galaxies NGC628 (M74), NGC5457 (M101), NGC598 (M33), and NGC300 to motivate the use of chemical and dust evolution models for disentangling the different evolution mechanisms within these galaxies by explaining the oxygen abundance and the nitrogen-to-oxygen abundance ratio explains the differences in the dust-to-stellar mass ratio and the dust-to-metal ratio.

12 - Talk: Mid-Infrared Emission as a Tracer of Gas and Star Formation in M51

Mansi Padave

University of California San Diego

Recent research efforts highlight that the mid-infrared (mid-IR) dust emission shows a strong relationship with both molecular gas and star formation in galaxies across various spatial scales, establishing it as a powerful probe of the interstellar medium. Building on these findings, I will present an investigation of the correlations of mid-IR emission with gas and star formation in M51, leveraging the high-resolution JWST wide-band imaging covering all MIRI filters (at 5.6, 7.7, 10, 11.3, 12.8, 15, 18, and 21 um) complemented by a rich ancillary dataset. We find that the mid-IR and molecular gas traced by 12CO(1-0) intensities exhibit near-linear slopes and a strong correlation that remains consistent across all mid-IR bands at ~50 pc scale. We observe a similar trend between mid-IR and H-alpha emission tracing star formation, with correlations strengthening in nebular regions. I will also discuss how the correlations of mid-IR emission with atomic gas (HI) and total gas (H I + H2) change, finding a strong correlation coefficient of $\sim$0.9 across all bands for the latter. Our results reveal the dependence of dust emission on both the gas column density and stochastic heating from UV photons. These findings will aid future studies in using mid-IR emission as a tracer of gas and star formation.

13 - Talk: Universal Blacksmith: How to Decipher a Galaxy’s Formation History from Stellar Metal Abundances

Lucas Kimmig

University Observatory Munich, LMU

Metals play an essential role in a galaxy’s life, as they are important ingredients for the cooling processes in the gas component, but also influence the lifetimes of the stars and encode information about the star formation histories of galaxies. However, most of our understanding on how to interpret the observed metallicities to decipher a galaxy’s formation history so far originates from closed box models or idealized formation scenarios. Using the cosmological volume Magneticum simulations and its successors, I will present how metallicities evolve in realistic galaxy formation pathways that are dominated by accretion, merging, and feedback cycles. I will show that high levels of alpha elements in the stars reflect galactic formation histories dominated by extreme star formation bursts short enough to allow only enrichment by supernovae Type II, while a continuous star formation history imprints in a higher iron abundance reaching up to super solar values. I will demonstrate that these abundances can even be used in quiescent galaxies to infer their quenching times, and the number of star formation episodes. Furthermore, I will discuss the importance of high-resolution observations of the metal content to even locate different epochs of star formation radially. Finally, I find that the alpha abundance can tightly predict both the formation and assembly redshift, i.e., the median age of the stars, and when half of them first assembled into a single progenitor galaxy.

14 - Talk: Unveiling gas (in)flows in barred galaxies: Insights from PHANGS Observations

Marina Ruiz-García

Observatorio Astronómico Nacional (OAN-IGN)

Galactic bars are interesting central features that are thought to drive gas from the galactic disk towards the center of a galaxy through bar lanes. This gas inflow can trigger nuclear star formation, fuel supermassive black holes (SMBHs) and, indirectly, it can control active galactic nucleus (AGN) feedback. Therefore, measuring inflow rates is key to understanding the evolution of galactic nuclei. In this work, we focus on the central region of the weakly-barred spiral galaxy NGC 4303 using high-resolution maps from the PHANGS-ALMA survey. This observational approach allows us to study the interplay between nuclear activity and gas inflows. By combining observations with hydrodynamical simulations, we can assess the efficiency of gas transport in fuelling the nucleus, and their potential role in triggering AGN activity. Our findings offer valuable insights into how galactic-scale processes influence the growth and feedback of SMBHs, offering new perspectives on the evolution of galaxies and their central regions.

15 - Talk: MAUVE-ALMA: Dissecting Environmental Quenching of Virgo Galaxies with Small-scale Gas Physics

Jiayi Sun

Princeton University

I will present MAUVE-ALMA, an ongoing large ALMA CO survey at sub-arcsec resolution covering 40 disk galaxies in the nearest Virgo cluster. Together with the MAUVE (MUSE and ALMA Unveiling the Virgo Environment) Large Programme on VLT/MUSE, we are spatially resolving the gas-star formation-feedback cycle on ~60 pc scales and establishing its roles as the interface and small-scale manifestation of environmental quenching on global galaxy scales. We are measuring the distribution, dynamical state, and star formation efficiency of some 20,000 molecular clouds, thereby pinpointing the *fundamental cause* of star formation quenching (or local enhancement) in Virgo galaxies. We will also combine the kinematics of molecular gas (CO), ionized gas (Halpha), and stars (optical continuum) to probe not only gas flows within galaxies but also those leaving in outflows and stripped tails. I will showcase preliminary science results on the molecular gas distribution in relation to ram pressure stripping and infall stage into Virgo. I will also briefly discuss other active science projects, related efforts on expanding the multiwavelength coverage, and plans for data and science dissemination to the community.

16 - Talk: Bar-spiral interaction produces radial migration and star formation bursts

Léa Marques

Leibniz Institute for Astrophysics Potsdam

Central bars and spirals are known to strongly impact the evolution of their host galaxies, both in terms of dynamics and star formation. Their typically different pattern speeds cause them to regularly overlap, which induces fluctuations in bar parameters. I will show, using both numerical simulations and observations, how bar-spiral physical overlap produces both migration and star formation boosts on the timescale of their beat-frequency. On the one hand, this mechanism can send stars from the bar radius out to the solar neighborhood on cold orbits. On the other end, it can enhance star formation by a factor of up to 4 when the bar and the spiral are connected, depending on the strength of the spiral structure. This is in agreement with various observational studies seeing a revival of star formation rates at the end of the bar, compared to its decrease along the bar major axis. The bursts do not always happen simultaneously at the two sides of the bar, hinting at the importance of odd spiral modes. Resolved observations of nearby face-on galaxies could provide comparisons of star formation rates from the two sides of the bar, therefore probing the symmetry of their spiral structure.

17 - Talk: The stellar mass growth of bulges and discs across cosmic time

Adriana de Lorenzo-Cáceres

Instituto de Astrofísica de Canarias

The formation of stellar structures in galaxies is intimately connected to all evolutionary processes. Violent mergers prevent or destroy fragile discs, while minor mergers are able to promote the formation of classical bulges. Secular evolution favours the formation of bars, rings, nuclear discs, etc. The assembly history of stellar structures holds crucial information about the full lives of their hosts. We present the cosmic evolution of the mass growth of bulges and discs in a selection of 129 unbarred galaxies from the CALIFA survey. After separating both components through innovative spectrophotometric decompositions performed with the C2D code, we find a clear trend that more massive bulges, as well as bulges in more massive galaxies, assemble the majority of their stellar mass quicker than lower mass bulges or bulges in lower mass galaxies. Moreover, at least half of the bulge stellar mass is already in place at $z \sim 1$ for all galaxies. Discs, on their side, form later than bulges, with a delay between the mass growth of bulges and discs that is dependent on galaxy mass. All our results point towards a Universe in which bulges act as seeds for galaxy formation, driving the properties of the discs that will be born later.

18 - Talk: Dynamically-Driven Molecular Gas Evolution and Star Formation

Jin Koda

Stony Brook University - SUNY

I will discuss the evolution of molecular gas and subsequent star formation/feedback across the entire disk of the barred spiral galaxy M83, where we have the ALMA CO J=1-0 and 2-1 line maps at about x10 higher sensitivity (10^4Msun) and x2-3 higher resolution (40pc) than those of PHANGS. The CO 2-1/1-0 ratio map clearly shows the large-scale variations of gas physical conditions as a function of galactic structures. The density and temperature of the bulk gas systematically increase by a factor of 2-3 from the interarm regions to the bar and spiral arms. This gas evolution occurs even without (massive) star formation and is likely controlled by large-scale galactic dynamics. HII regions appear as a consequence of this evolution, and their feedback pushes the gas density and/or temperature even higher. However, the impacts of the feedback is localized to their vicinity and is limited in the galaxy-scale gas evolution. A similar evolutionary sequence is seen in the underlying populations of molecular clouds. Low-mass, unbound clouds without star formation are abundant in the interarm regions, and become more massive/bound in the bar and spiral arms and form stars there. Therefore, both stellar feedback and galactic dynamics should be considered as the energy sources for ISM evolution, star formation, and galaxy evolution (Koda et al. submitted). The similar evolutionary trends are also being confirmed in other spiral galaxies in our on-going ALMA survey.

19 - Talk: Molecular gas properties and star formation in nearby jellyfish galaxies

Pavel Jachym

Astronomical Institute, Czech Academy of Sciences

The ALMA JELLY project observed a sample of 28 jellyfish galaxies in the nearby clusters Coma, Leo and Norma. The sample galaxies cover a range of evolutionary stages of the interaction with the surrounding intra-cluster medium, allowing to study the evolution of molecular component of the galaxies from early to late stages of ram pressure stripping. We will present the results of the ALMA JELLY survey, focusing on the incidence and properties of molecular component, as well as on the efficiency of star formation. As part of the ALMA JELLY project, we have supplemental high-resolution observations of CO, HCN, HCO+ lines for one of the best galaxies in the sample. At a 100 pc resolution, these observations reveal for the first time physical parameters of the molecular clouds that have formed in-situ in the stripped tail, out to nearly 40 kpc away from the parent galaxy.

20 - Talk: Unraveling Star Formation in M51 with High-Resolution Molecular Line Mapping

Ina Galić

Argelander Institute for Astronomy

Through new NOEMA (Northern Extended Millimetre Array) observations of the M51 galaxy, our team is trying to address the gap between galactic and extragalactic CO and CO isotopologue studies. As part of the SWAN (Surveying the Whirlpool at Arcseconds with NOEMA) survey, this data maps 13CO, C18O and multiple dense gas emission lines in the inner 5 x 7 kpc2 at the unprecedented resolution (~125 pc) for a galaxy of this type. We analyze how the spatial distribution of 13CO(1-0) and C18O(1-0) emission in M51 varies with opacity and molecular abundance, revealing underlying gas conditions across diverse environments (nuclear bar, molecular ring, spiral arms and interarm regions). We find a moderate positive correlation between the 13CO(1-0)/C18O(1-0) ratio and galactocentric radius and a moderate negative correlation with star formation rate surface density. While the overall trends align with previous kiloparsec-scale studies - suggesting that the physical and chemical processes governing these emission lines operate similarly across both scales - variations across environments suggest localized processes play a larger role than previously expected. To further pin-down the impact of stellar populations and feedback processes on the interstellar medium, we attempt to capture the star-formation process in its entirety by combining SWAN with JWST-FEAST. Together, these datasets offer a novel view into the physical and chemical conditions closely linked to recent star formation.

21 - Talk: WISDOM: Molecular Cloud Properties and Star-formation Quenching in Spheroids

Martin Bureau

University of Oxford

Molecular gas is the fuel for star formation in galaxies. Using observations from the mm-Wave Interferometric Survey of Dark Object Masses (WISDOM), that spatially resolve (1-30 pc) individual molecular clouds across the Hubble sequence, I will reveal a clear dependence of the nature of the molecular interstellar medium of galaxies on Hubble type. I will then highlight the shortcomings of the usual virial approach to clouds as self-gravitating objects, and stress the importance of the external galactic potential and in-plane shear to regulate the dynamical states of clouds. I will illustrate these issues with several observations that reveal few or no clouds in regular extended molecular gas discs, and peculiar clouds properties within bars. Finally, using diverse observations of star-formation tracers, I will discuss the impact of these different mechanisms on the star-formation efficiency of clouds and thus the quenching of star formation, particularly in galaxy nuclei and spheroids (morphological quenching).

22 - Talk: WISDOM: Cloud-scale Molecular Gas Properties of the Lenticular Galaxy NGC1574

Ayu Konishi

Osaka Metropolitan University

Understanding how giant molecular cloud (GMC) properties vary as a function of galaxy type and high-mass star formation provides crucial insights into galaxy evolution. To probe morphological quenching, the WISDOM project expands spatially-resolved studies to early-type galaxies and bulges. Here, I present the results of Atacama Large Millimeter/submillimeter Array 12CO(J=2-1) observations of the nearby lenticular galaxy NGC1574 at ~10 pc resolution. These reveal a molecular gas disc extending to a radius of only ~100 pc. This disc is very smooth and symmetric, and there are very few cloud-like structures at the usual cloud spatial scales (~50 pc), although some emerge at smaller scales (~10 pc), whose properties and gravitational boundedness can be accurately measured. We argue that this is due to strong shear in the galaxy's nucleus, and speculate on the link to star-formation regulation.

23 - Talk: Are GMCs real? Searching for a virialized scale in NGC 253

Elias Oakes

University of Connecticut

Giant Molecular Clouds (GMCs) are widely described as the key structures of early star formation. However, the hierarchical and complex nature of the interstellar medium (ISM) means that cloud-like objects can be seen above and below the canonical GMC scales of 50-100 pc, raising the question of whether GMCs are physically motivated, well-defined entities. In this work, I will describe a search for the characteristic size scale of gravitationally bound objects. I will present the ALMA Zoom field, which maps 12CO(2-1) at 0.4" ~= 7 pc spatial resolution over 1.4 kpc^2 in the disk of NGC 253. Using dendrograms, we have conducted a scale-free, hierarchical decomposition of these data to identify 2463 candidate structures with sizes ranging from R~2 to 500 pc. We estimate the bound state of each structure, i.e. whether we expect it to be gravitationally coherent or not, using the virial parameter. By comparing the virial parameter against physical properties including the size, mass, surface density, and hierarchical position of structures, we have carried out a comprehensive search for a preferred scale at which bound structures emerge. Ultimately, we do not find any emergent scale for cloud-like structures in our data. These findings suggest that gravitational binding cannot be used to define GMCs and emphasize the need for structure-agnostic approaches to characterize the ISM.

24 - Talk: Giant molecular clouds in passive lenticular galaxy NGC1387

Fuheng (Eric) Liang

Heidelberg University

Molecular gas is a key to understanding star formation and galaxy evolution. However, only over the past decade and with the capabilities of ALMA, spatially resolved observations of giant molecular clouds (GMCs) beyond the Local Group have become widely feasible. The passive lenticular galaxy, NGC1387, has a molecular gas disc revealed by ALMA CO(2-1) observations at 15 pc resolution. We identify 1592 individual GMCs and measure their properties (radius, velocity dispersion, gaseous and dynamical mass, etc). We find NGC1387 GMCs follow very similar scaling relations as those in the Milky Way disc and other late-type galaxies. This is surprisingly different from other early-type galaxies studied in recent years. Also, the GMCs are perfectly virialised, which means they are gravitationally bound and tend to collapse. The Toomre instability parameter of the gas disc indicates potential star formation as well. Despite these properties, NGC1387 is far from the general population in star-formation efficiency as shown by VLT/MUSE Ha observation. I will discuss possible reasons behind this discrepancy. This study showcases the power of high spatial resolution in revealing accurate cloud properties and advancing physical understanding.

25 - Talk: The multi-phase ISM shaped by the baryon cycle in nearby galaxies

Andrea Romanelli

Heidelberg University

Galaxies are in constant evolution, under the influence of the gas-star matter cycle within them. However, the exact physical mechanisms driving this multi-scale cycle remain elusive, due to a lack of observational constraints. By combining high-resolution, multi-wavelength observations from a broad range of galactic environments, I will present how we can characterise the successive steps of this cycle, from the assembly of dense gas clouds from the diffuse interstellar medium, to the successive collapse, star formation and dispersal by stellar feedback redistributing matter and energy back into the diffuse medium. I will show that molecular clouds are rapidly destroyed by pre-supernova stellar feedback (within 1-5 Myr), which drastically limit their star formation efficiency to 2 to 10%, depending on the galactic environment. The vast majority of momentum and energy emitted by the young stellar populations escapes the parent cloud, affecting galaxies on large scales. This comprehensive analysis sheds new light on the matter cycle within galaxies, revealing its underlying processes and quantitative characteristics. I will conclude by showing how these measurements provide critical constrains to improve the description of the unresolved processes of star formation and feedback in galaxy formation and evolution simulations.

26 - Talk: Tracing the lifecycle of gas clouds: PAH emission and molecular cloud evolution in nearby galaxies

Jaeyeon Kim

Stanford University

Recent JWST mid-infrared (mid-IR) images, capturing emission from polycyclic aromatic hydrocarbons (PAHs) and dust, reveal detailed gas distributions in nearby galaxies shaped by large-scale dynamics and stellar feedback. By leveraging PHANGS-JWST Cycle 1 and PHANGS-MUSE observations, we characterize the lifecycle of gas clouds from the PAH-emitting phase to HII regions across 17 nearby galaxies. We achieve this by analyzing the spatial distributions of mid-IR emission (7.7-11.3um) relative to Halpha emission as a function of spatial scales. In most galaxies, we find that the lifetimes of gas clouds measured by mid-IR closely match those traced by CO. This suggests that once gas clouds form, they quickly provide enough shielding for stable CO formation, particularly in molecular gas-rich galaxies with near-solar metallicity. Radiation fields from HII regions illuminate the surrounding PAHs and dust, resulting in a significant overlap (~70%) of the Halpha-emitting phase and mid-IR emission. Interestingly, despite the strong correlation between PAH and CO emission, we identify 1 kpc-long molecular gas ridges in several galaxies that are over 10 times brighter in CO than expected based on PAH emission. These ridges, located in dynamically complex regions such as spiral arms and bar ends, demonstrate that interstellar PAH processing (shattering or coagulation) and large-scale shocks significantly influence the molecular gas and dust properties in these environments.

27 - Talk: Interplay between stars, the ISM and galactic environments on resolved scales

Helena Faustino Vieira

Stockholm University

To understand whether star formation is solely dependent on the local conditions of the interstellar medium (ISM), or if it is also affected by the large-scale galactic dynamics, we must probe the small physical scales of star-forming clouds as well as the wider galactic context. I present our optical dust extinction technique with which we study the resolved properties of the extragalactic ISM, since it allows us to image the dust/gas of nearby galaxies at cloud-scales (<10pc) over several kiloparsecs. For our sample of spirals, we find some changes in ISM properties depending on galactic environments and dynamics, with galactic centers showing higher surface densities than the discs whereas arm/inter-arm differences are more subtle. The next step is to understand the interplay between stellar feedback and natal clouds. The advent of JWST has allowed us to unveil the still embedded young star clusters (eYSCs) at unprecedented detail. I will showcase our pilot NIRSpec/MOS study of a representative sample of eYSCs in NGC628, which allow us to characterize eYSCs and their surrounding ISM. Spectroscopy at 1-5um gives us a direct imprint of the mechanisms at work during the cluster emergence phase, probing both the ionizing conditions and extinction (through H and He recombination lines), and photo-dissociation region properties. Additionally, spatial variations of PAH 3.3um emission (with distance to eYSCs) can tell us about the evolution of dust properties as clusters emerge.

28 - Talk: Dust as a High Resolution Tracer of Stellar Feedback and Gas

Debosmita Pathak

The Ohio State University

I will present recent high-resolution measurements of ISM structure, radiation feedback, and PAH fractions in nearby galaxies based on mid-infrared emission and optical spectroscopy from the PHANGS JWST and MUSE surveys. JWST mid-IR images reveal complex substructure that simultaneously traces the distribution of dust and gas as well as heating from young stars. We measure the distribution functions (PDFs) of this mid-IR emission and show a common behavior where star-forming regions form a power-law tail while diffuse emission exhibits a log-normal distribution, which traces the underlying gas column density distribution. Within the star-forming regions, we combine JWST, MUSE, and HST to measure the strength of dynamical feedback mechanisms, including a first-ever estimate of the strength of total IR reprocessed radiation pressure in a large (~18,000) set of HII regions. We find that the IR pressure term is of order 5-10% of the UV radiation pressure from young stars, and that both terms are typically subdominant relative to thermal pressure from photoionization heating. Finally, we will share new results on the contribution of old stars to the gravitational potential of HII regions and molecular clouds, and on the variation in PAH abundance observed by JWST in the diffuse ISM of more than 70 nearby galaxies.

29 - Talk: Unveiling Ionization and ISM Evolution in Virgo Cluster Galaxies with MAUVE

Toby Brown

National Research Council of Canada

The MAUVE (MUSE and ALMA Unveiling the Virgo Environment) Survey is a large multi-wavelength program investigating how environment influences the gas-star formation cycle in Virgo cluster galaxies. Combining new VLT/MUSE optical integral field spectroscopy and ALMA CO(2-1) mapping, MAUVE systematically probes the full extent of the molecular gas disks in 40 late-type Virgo Cluster galaxies at various infall stages on the scale of individual star-forming regions and molecular clouds. In this talk, I will present new results from MAUVE that reveal systematic differences in the ionized gas properties between cluster and field galaxies. Using spatially resolved emission-line diagnostics and velocity dispersion measurements, we show that Virgo cluster galaxies exhibit a significant reduction in star formation-driven HII region ionization compared to field galaxies. This is accompanied by a strong enhancement of high-dispersion, non-HII ionization sources, consistent with shocks, diffuse ionized gas, and post-AGB heating. These findings highlight how Virgo's environmental processes transform the ISM, suppressing star formation while enhancing alternative ionization mechanisms, ultimately driving galaxy quenching.

30 - Talk: Towards a 3D view on star formation regulation in nearby and high-z discs

Cecilia Bacchini

DARK - University of Copenhagen

Star formation (SF) regulation is key to understand galaxy formation and evolution. A few studies concluded that disc instability (DI) takes over stellar feedback as the main driver of SF in extremely low and high density regimes. This was based on observations of high turbulence at high z and breakdowns in SF laws, and corroborated by the increasing number of unstable discs found at high z. However, these studies neglected key properties of discs: their thickness and flaring. I present recent works improving on this. 1st, the lower break in SF laws is due to the projection effects caused by the flaring on the observed surface densities. Using a sample of well-resolved nearby dwarfs and spirals, a very tight and unbroken volumetric SF law emerges by removing the project effects. 2nd, turbulence dissipation slows down with increasing disc thickness. Using a sample of spatially-resolved star-forming discs up to z=5, we find that feedback sustains the cold gas turbulence with few percent of the supernova energy. 3rd, a thick disc is more stable than a thin disc. In our sample, about half of the high z discs are locally unstable vs none at z=0, but the unstable regions contain a small gas fraction and do not coincide with the peaks of SF and turbulence. These results suggest that SF self-regulates via feedback, while DI is secondary at most. Lastly, I present ALMA and MeerKAT surveys that will get high-resolution data for high-z and extreme systems, pushing our studies further.

31 - Talk: Structure and porosity of the multiphase ISM in nearby spatially resolved galaxies

Lise Ramambason

University of Heidelberg

Nearby galaxies observed at high spatial resolution with JWST, ALMA, and MUSE allow us to address fundamental questions related to the influence of young stars on their surrounding interstellar medium (ISM), from giant molecular clouds (GMC; 50 - 200 pc) to galactic scales: How far can ionizing photons travel, and which physical mechanisms favor their escape from HII regions? How do such processes shape the ISM and influence galactic evolution? I will first present constraints on the timescales and physical mechanisms associated with the evolutionary cycle of GMCs in 37 galaxies from the PHANGS-JWST survey, including their dust-embedded star formation phase. We find that the embedded phase of star-formation is short (< 4 Myr) and is drastically reduced in late-type galaxies, hosting GMCs of smaller masses. Strikingly, this phase seems absent in galaxies with a metal-poor ISM, that may host different populations of HII regions, possibly associated with ionizing photon leakage. To further investigate the physics at play in such environments, I will present results obtained using a catalog of HII regions (~70pc) obtained with MUSE in 13 dwarf galaxies, that extend the mass and metallicity range probed by PHANGS. Using multicomponent models to interpret their spectral data, we infer the main physical properties of their HII regions, including the escape fraction of ionizing photons, and assess how the local porosity to UV photons may affect the ISM at larger scales.

32 - Talk: PAHs around HII regions across 42 nearby galaxies

Oleg Egorov

Heidelberg University

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous in the ISM in ~Solar metallicity galaxies and playing a critical role in heating and cooling processes and reprocessing a significant fraction of the stellar radiation. Meanwhile, they are deficient in HII regions. Using JWST and MUSE observations of 42 nearby galaxies, we analyze the PAH fraction towards the over 12000 HII regions spanning a gas-phase oxygen abundance range 12 + log(O/H) = 7.9 - 8.7. We observe a steep decrease of the PAH fraction with decreasing metallicity below 12+log(O/H) < 8.2. In the higher metallicity regime, PAH fraction strongly anti-correlates with the ionization parameter. The result is the largest systematic measurement of band ratios tracing PAH fraction in spectroscopically characterized ionized gas nebulae. Our findings are consistent with the scenario in which PAH suppression in HII regions is mainly caused by hydrogen-ionizing UV radiation, or something correlated with it, is the dominant source of PAH destruction.

33 - Talk: Physical processes linking scale-free hierarchical star formation with host galaxy properties

Shashank Gairola

Indian Institute of Astrophysics

Star formation (SF) is a major driver of galaxy evolution & the baryon cycle. SF is a hierarchical process that begins with the collapse of GMCs. Supersonic turbulence & gravity govern this collapse & it results in a scale-free, hierarchy of molecular gas. Stars born out of this gas inherit similar hierarchical structuring. Our recent study of hierarchical SF in nearby spirals using 1.5”resolution FUV+NUV data from the UltraViolet Imaging Telescope reveals that the stellar matter hierarchy in galaxies spans from 10s of pc up to a few kpc. Turbulence produced by multi-scale sources like feedback, shocks & cloud collisions can link the different scales of SF (A&A, 693, A188 (2025)). But, the SF hierarchy does not extend to the entire galaxy size & is ultimately limited by the local gravitational potential & galactic shear. The parameters describing the SF hierarchy of galaxies depend strongly on its morphology, M* & type of spiral arms. Within individual galaxies, variation in ambient pressure, turbulence, or external galaxy interactions can cause radial or azimuthal variations in the hierarchy parameters. Our current study of 10pc scale HII regions from the PHANGS-MUSE survey shows that stellar feedback has a detrimental impact on the hierarchical distribution of gas around SFing regions. With these projects, we seek to link the sub-kpc scale hierarchical SF to global galaxy properties & explore the role of turbulence, feedback & environment on the baryon cycle in galaxies.

34 - Talk: Cosmic evolution of the star formation efficiency in Milky Way-like galaxies.

Alvaro Segovia Otero

Tsinghua University

Star formation and feedback shape ecosystems within and around galaxies, yet the details on how they affect the interstellar medium (ISM) and shape galactic-scale star formation histories are actively debated. In my talk I use the high resolution (20 pc) VINTERGATAN cosmological zoom-in simulation to study the evolution of the ISM and its star formation efficiency per free-fall time on giant molecular cloud (GMC) scales across cosmic time. The simulated Milky Way-like galaxy experiences periods of starburst activity and short global gas depletion times ($1 < z < 5$) when the cold ISM reaches its densest and most turbulent states. More quiescent star formation during a secularly evolving phase ($z < 1$) shows a less dense and turbulent cold ISM with order of magnitude longer global gas depletion times of a few Gyr. Despite significant changes in global star formation timescales, density, and velocity dispersion distributions as a function of redshift, the average star formation efficiency remains at a constant ~1%. This is due to the coupling between the kinetic-to-gravitational energy ratio in star-forming regions with time, consistent with resolved observations of star-forming GMCs (cf. PHANGS). By connecting state-of-the-art simulations with observations, my results can help relieve tensions between turbulence-regulated efficiency models and observational efficiency estimators, improving our understanding of the mechanisms regulating star formation and feedback in galaxies.

35 - Talk: Characterizing Starbursts: Mapping the Physical Conditions of NGC 253 with Neural Networks

Erica Behrens

University of Virginia

Starburst galaxies exhibit powerful, complex networks of star-formation feedback processes that heat and interact with interstellar gas and dust. Recognizing how feedback from one generation of stars affects the material that will form the next is crucial for understanding both the life cycle of star formation in starburst galaxies as well as how starbursts fit into galaxy evolution overall. By comparing molecular gas measurements to chemical models, we can constrain the physical conditions of star-forming regions and investigate the dominant feedback mechanisms influencing gas properties. To model more star-forming regions at higher resolution, we implement neural network-based models to replace the role of time-consuming chemical models in parameter inferencing algorithms. I will demonstrate that we can use neural networks to reproduce the output of chemical models in a fraction of the time, allowing us to analyze molecular gas conditions in nearby galaxies more completely than ever before. We constrain our models with ALCHEMI measurements of HCN and HNC toward NGC 253 and infer key molecular gas properties, (e.g. volume density, cosmic-ray ionization rate) across NGC 253 on 50 pc scales. We find that cosmic-ray ionization plays a dominant role in the feedback budget in NGC 253's nucleus, while UV heating may prove more important farther from the nucleus. I will discuss potential causes of this distribution in feedback mechanisms and its impacts on future star formation.

36 - Talk: The gas discs of galaxies as probes of the baryonic physics of galaxy evolution

Jindra Gensior

Institute for Astronomy, University of Edinburgh

The exact nature of the star formation (SF) and feedback (FB) physics driving galaxy evolution remains uncertain. Understanding what shapes the cold gas component, which both provides the fuel for SF and is strongly affected by the subsequent stellar FB, is a crucial step towards a better understanding of the baryon cycle and thus galaxy evolution. I will present detailed analysis of a sample of 60 Milky Way halo-mass galaxies from cosmological simulations. This set of simulations comprises galaxies evolved self-consistently across cosmic time with several different SF and stellar FB models (including early stellar FB). I show that despite broadly similar stellar masses at z=0, other galaxy properties, particularly those of the cold interstellar medium (ISM; e.g. mass, density, morphology) differ significantly between the samples evolved with different baryonic physics. This is a direct consequence of the different models leading to SF in different ISM conditions, thus affecting the impact of the subsequent stellar FB and further evolution of the galaxy. Finally, focussing on the neutral gas, I will demonstrate that the ISM morphology is a particularly promising observable to disentangle the degeneracy between the physics of SF and stellar FB. Comparing the predictions from these simulations with the wealth of observations expected from current and upcoming facilities (e.g. SKA) will significantly advance our understanding of the baryonic physics driving galaxy evolution.

37 - Talk: The Role of Disc Properties in Driving Galactic Winds: Insights from QED Simulations

Aditi Vijayan

The Australian National University

Galactic-scale winds driven by supernova (SN) feedback in Milky Way-mass galaxies play a critical role in shaping global mass and metal distributions and are known to be multiphase. The mass, energy, and metal loading factors of these winds in the different phases quantify how these winds regulate gas cycling in the circum-galactic medium. However, the link between SN distribution and wind properties remains poorly constrained. I will present results from the QED suite of high-resolution, 3D hydrodynamic simulations run with the GPU-accelerated code Quokka. These simulations track SN-driven outflows with pc-scale spatial resolution needed to resolve mass and metal exchanges between different gas phases. We systematically explore how wind properties vary with SN distribution and gas surface density. We find that the winds fall into three broad categories: steady and hot, multiphase and moderately bursty, and cool and highly bursty. Each of these categories are identified by a distinct combination of loading properties. The most important factor in determining the kind of wind a galaxy produces is the ratio of supernova to gas gas scale heights, with the latter set by a combination of SN rate, metallicity-dependent cooling rate, and the gravitational potential. Our findings suggest that the nature of galactic winds is likely highly sensitive to phenomena such as runaway stars occurring at a large height and dense gas and are poorly captured in most simulations.

38 - Talk: Connecting the physics of gas & star formation- from parsec to galaxy-scales with WISDOM and KILOGAS

Timothy Davis

Cardiff University

Our current understanding of the role of cold gas in galaxy evolution was constructed by studying samples of hundreds of unresolved galaxies to scan the full galaxy population, several dozens of (primarily) disc galaxies at~kpc resolution, & now a similar number of systems at ~hundred pc resolution. Here I will report on our efforts to make the next steps: WISDOM - which maps the centres of spiral & early-type systems in CO at ~10-20pc resolution, & KILOGAS, a large ALMA program mapping ~500 nearby galaxies at kiloparsec resolution; each of which has existing IFU data providing a resolved view of their stellar & ionised gas properties. I will show using observations at tens of parsec scales (from ALMA, SITELLE & MUSE), along with simulations, that the gas in galaxies cares about the potential at larger scales. Shear, spiral arm streaming & bars all affect both its small-scale spatial distribution & can impact the efficiency of star formation. I will then present KILOGAS first results, showing how we can apply the lessons learned at small scales, benchmarking them on a fully representative survey of local volume galaxies with much greater statistical power. With the advent of large ALMA surveys, combined with optical IFU information, we can provide the link between the small scale physics & more global properties. This powerful information is vital to explain the trends seen in unresolved studies, & guide our interpretation of what is seen in the higher redshift universe.

39 - Talk: Star formation quenching from global to cloud scales

Dario Colombo

AIfA, University of Bonn

Understanding why galaxies stop forming stars is a key challenge in galaxy evolution. The "star formation quenching" can result from complex physical processes, including AGN activity, large-scale dynamics, and galactic environment. The CALIFA IFU survey provides kpc-resolved stellar population and ionized gas data for ~1000 local galaxies, but to fully understand quenching requires molecular gas information. To address this, we developed iEDGE, a database combining molecular gas, nebular emission, and stellar continuum data for 643 CALIFA galaxies, observed in CO with APEX, CARMA, and ACA. We find that molecular gas fraction and star formation efficiency (SFE) evolve differently, with low central SFE driving galaxies from the green valley to the retired sequence, highlighting the role of large-scale dynamics in quenching. To connect to cloud-scale physics, we analyzed PHANGS-MUSE/ALMA galaxies, finding 4× fewer Giant Molecular Clouds in retired regions compared to star-forming ones, with lower density and, possibly, higher turbulence. In these systems, these regions often appear to be associated with stellar bars, where shear and inflows might suppress star formation. Finally, we speculate that the Milky Way exhibits key green valley characteristics, providing a unique opportunity to study quenching at the highest resolution.

40 - Talk: Beyond the Bulge: Rethinking Galaxy Structure with High-Resolution IFS Surveys

Jesse van de Sande

The University of New South Wales

Understanding how galaxies build up mass and angular momentum is key to understanding their diverse morphology, structure, and dynamics in the present-day Universe. Traditionally, bulge formation has been linked to mergers in galaxies with dispersion-dominated centres with high Sérsic indices, whereas secular processes are thought to shape all other central components. In this talk, I will show how global IFS measurements from the SAMI Galaxy Surveys challenge the traditional view that accretion predominantly drives bulge formation, revealing significant scatter between bulge-to-total ratio, Sérsic index, and V/σ. Additionally, while a correlation exists between a galaxy's global intrinsic thickness and its mean stellar population age, the scatter in this relation points to multiple competing internal and external physical small-scale processes. With the recent advent of high-resolution IFS surveys like TIMER, PHANGS, MAUVE, and GECKOS, we now have the tools to address the complexities of bulge formation with unparalleled precision. Utilising edge-on GECKOS data, I will present a cautionary tale of how different central structures, such as edge-on bars and thick disks, can be misidentified as classical bulges. At the same time, I will show how the diverse GECKOS sample—including the discovery of a counter-rotating stellar thick disk—sheds light on the physical processes driving the observed scatter in bulge properties.

41 - Talk: mm-spectroscopy in massive, Galactic star forming regions from LEGO (in a nearby galaxy context)

Frank Bigiel

Argelander Institute for Astronomy

I will present recent results from the IRAM 30m large program LEGO, studying star-forming regions in the Milky Way across a wide range of environments to help interpret extragalactic observations of molecular line emission. Our recent work has focused in particular on several prominent, massive star forming regions, serving as excellent templates of regions bright enough to be observed in other galaxies. I will show new results probing canonical extragalactic molecular gas tracers like e.g. N2H+, HCN, HCO+, HNC or CS and their emissivities in particular as a function of gas density. Of particular interest is the scale dependence of such lines and canonical ratios from sub-cloud to cloud scales, where we find HCN (also HCO+, HNC, CS) having a roughly fixed ratio with N2H+, the Galactic "gold standard" tracing star forming gas, motivating the use of observationally cheaper HCN or HCO+ observations as proxies for such denser molecular gas at scales larger than that of individual clouds. Similarly, and comparing to recent extragalactic surveys of the same lines, canonical line ratios like HCN-to-CO are found to scale consistently with other gas density metrics from parsec to kiloparsec scales. These and related results highlight the potential of finally bridging the gap between star forming regions in the Milky Way and other local galaxies, by combining surveys like LEGO with recent, high-resolution surveys in local galaxies using a matched set of observational tracers.

42 - Talk: Dense gas under the microscope: a high-resolution view on dense gas and star formation with ALMA

Lukas Neumann

ESO

Dense gas is the fundamental fuel for star formation, yet its conversion efficiency and timescales across and within galaxies remain poorly understood. In this talk, I will present recent ALMA spectral line observations of the nearby star-forming galaxy NGC 4321 (Neumann et al. 2024). These new 260-parsec resolution data provide the most sensitive, high-resolution, full-galaxy perspective on dense gas tracers (HCN, HCO+) in nearby star-forming galaxies. By combining these observations with cloud-scale data on bulk molecular gas (ALMA), hot dust (JWST), and ionised gas (VLT-MUSE) from the PHANGS collaboration, we gain an unprecedented, detailed view of molecular cloud properties and their star-forming potential across diverse galactic environments, including the central molecular zone, the galactic bar, bar ends, spiral arms, and interarm regions. Our findings on the dense gas fraction (traced by HCN/CO) and star formation efficiency (traced by SFR/HCN) reveal that while molecular clouds experience strong external pressure toward the inner galaxy, they tend to decouple from their surroundings in the outer disk, where stars form in a more universal way. Furthermore, we identify the galactic bar as a distinct environment where star formation proceeds in an unusually inefficient manner. These findings underscore the necessity of high-resolution, multi-wavelength studies to fully understand the physical conditions governing star formation across diverse galactic environments.

43 - Talk: Illuminating Cosmic Origins: Advancing the Chemistry of Star Formation and Galaxy Evolution

Kathryn Grasha

Australian National University

In this talk, I will discuss the TYPHOON survey, the largest nearby sample of galaxies with 3D data cubes which will be used as a benchmark to calibrate and quantify the impact of variable stellar chemical abundances on emission lines. We will talk about enrichment at the scales of individual HII regions and how supernova yields inform on global mixing scales across entire galaxies. The work presented here represents a first step necessary in order begin providing clear constraints for galaxy evolution theory by combining observations and state-of-the-art modelling as the theoretical basis to derive new, robust galaxy diagnostics across cosmic time.

44 - Talk: Deficiency of current photoionisation models and the needs for highly-resolved studies like AMASE-P

Renbin Yan

The Chinese University of Hong Kong

Understanding feedback of star formation and chemical evolution of galaxies requires realistic models. However, spatially-resolved observations on kpc scales from SDSS-IV/MaNGA and 100 pc scales from PHANGS-MUSE have revealed many inconsistencies with current photoionization models of star-forming regions. Efforts resolving these puzzles are further complicated by small-scale spatial correlations between dust and ionized gas. These problems would directly lead to systematics in scaling relations such as mass-metallicity relations and its secondary dependences. I will discuss the results of our analyses in these directions, which could only be understood by new spectroscopy observations resolving sub-parsec or few parsec scales. To this end, we are developing the AMASE-P survey, which will be a wide-area integral field spectroscopy survey studying the ionized gas and dust in the Milky Way and nearby galaxies with a spatial resolution of subparsec to 10s of parsecs, and a spectral resolution close to $R\sim 15,000$. It will include both a northern survey and a southern survey, cover hundreds of square degrees of sky, and target Milky Way, LMC, SMC, M31, M33, and other local group galaxies. It is expected to start observing within a year. I will describe the progress of the project and its science prospects.

45 - Talk: Mapping Galaxy Evolution Through Spatially Resolved Star Formation Histories Using UVCANDELS

Charlotte Olsen

CUNY City Tech

Star formation is an important physical observable that traces the complex processes involved in galaxy evolution. The inflows and outflows of gas that drive star formation and quenching as well as the timescales upon which they act are still not well understood. We select 12 galaxies from the UVCANDELS survey where a total of 10 HST bands including UV follow up in F275W allow for us to reconstruct the star formation histories of multiple regions across each galaxy. We create spatially resolved maps of the galaxy regions colored by stellar mass, SFR, and sSFR to identify where and when stars are actively forming. We then reproduce the resolved star forming main sequence (rSFMS) for each galaxy at the time of observation and 1 Gyr lookback time noting the slope, scatter, and normalization for each. We compare offsets for each galaxy's slope, scatter, and normalization from the global trend. This allows us to explore how galaxies transition between clumpy and smooth star formation patterns and how these transitions are linked to a galaxy's stellar mass and SFR. Comparing the rSFMS with trends in the property maps we can infer the timing and location of bursts of star formation and better understand the connection between star formation and the ISM.

46 - Talk: When Opposites Collide: spatially-resolving sub-kpc physics in high-z galaxies with lensing & JWST

Taylor Hutchison

NASA Goddard

I will present spatially-resolved studies of the Waz Arc, an incredibly bright, massive (zAB mag 20.5), a gravitationally-lensed galaxy located at the tail end of the reionization era (z=5). This highly magnified (70x) galaxy allows a window into the inner workings and spatial locations of a diversity of stellar populations within clumpy regions situated in a (remarkably) metal-rich ISM down to sub-kpc scales – these scales are simply impossible to achieve without lensing and JWST. While globally, we identify this system as a post-starburst galaxy, strong lensing and JWST IFU spectroscopy enable measurement of the spatial extent and variation of key physical properties. We find a large dynamic range in nebular ionization conditions and gas-phase metallicities that are broadly not as metal-poor as other galaxies found at these epochs. Tying these spatially-varying physical properties with local star formation histories can help us uncover how the Waz Arc assembled over cosmic time. This distant galaxy is but one of many such highly-lensed, high-redshift systems along the early edge of cosmic star formation, filled with clumpy structures covering a wide variety of stellar and nebular properties. I will close by placing the properties of clumpy structures in the Waz Arc in context with the rest of a sample of several magnified and incredibly clumpy high-redshift systems from the JWST LEGGOS and TEMPLATES surveys, totaling to ~100hrs of JWST imaging and IFU spectroscopy.

47 - Talk: Bridging the Gap: Resolving Galaxy Assembly Across Cosmic Time with ALMA and JWST

Rodrigo Herrera-Camus

Universidad de Concepción

A decade ago, studying gas, dust, and stars on resolved scales was limited to nearby galaxies. Thanks to groundbreaking observations with ALMA and JWST, we can now extend these studies to normal, main-sequence galaxies at the dawn of the Universe, when it was only 1 billion years old. In this talk, I will present exciting results from the CRISTAL ALMA Large Program (www.cristal.udec.cl), which, for the first time, leverages the combined power of ALMA, JWST, and HST to spatially resolve gas, dust, and stars in a large sample of star-forming galaxies at $z = 4-6$ on kiloparsec scales. The achieved physical resolution corresponds to the Jeans length in high-redshift, gas-rich galaxies—similar to the 100 pc Jeans length we resolve in nearby galaxies, offering for the first time a direct connection between the physical processes in normal, main-sequence galaxies near and far. By studying star formation (both obscured and unobscured), dust and metal content, ISM properties, kinematics, feedback, and outflows in this early cosmic epoch, we have obtained new perspectives on how galaxies assembled and evolved. These results provide a unique opportunity to connect galaxy assembly across cosmic time, bridging our understanding of both distant and nearby galaxies, and directly addressing the main scientific goals of the workshop, including galaxy assembly, star formation and feedback, and their impact on local and global scales.

48 - Talk: The JWST LEGGOS Survey: Taking Galaxies Apart and Putting Them Back, a Clump at a Time

Gourav Khullar

University of Washington

I will present an overview of the JWST LEGGOS program (LEnsed Galaxies: Growth of Substructures) – an 85-hour Cycle 2 JWST survey to spatially and spectrally resolve the building blocks of star-forming galaxies at cosmic noon and beyond. LEGGOS uses the full range of spectral resolution available on the NIRSpec IFU mode for a sample of strong gravitationally-lensed galaxies to measure both stellar continuum (at R~100) and nebular line emission (at R~1000-2700) from resolved clumpy structures reaching down to 10's of parsecs in size. The JWST data allow us to precisely constrain the basic properties of these small clumps, including stellar population ages, sizes, dust content, metallicities, nebular ionization properties, and bulk dynamics. LEGGOS, for the first time, unpacks the diversity of stellar populations and star formation histories of individual clumps within distant star-forming galaxies, and allows us to directly reconstruct how those galaxies are assembled from their constituent structures. In this talk, I will present first measurements from LEGGOS that exhibit the diversity in star formation histories in 10-50 parsec regions beyond cosmic noon. The growing number of highly magnified systems with these measurements provides a path toward understanding mass assembly via the earliest star-bursting clusters in galaxies across cosmic time.

Posters

01 - Poster: Compact Obscured Star Clusters in the Nearby Starburst Galaxy NGC 253

Ashley Lieber

University of Kansas

NGC 253 (D=3.5 Mpc) is the nearest example of a nuclear starburst and with ALMA's capabilities, a prime candidate for studying intense star formation in detail. A majority of the star formation activity in this galaxy is concentrated in the central region of the galaxy within deeply embedded, massive star clusters. In the present day universe, the formation and evolution of massive star clusters is rare, however, it is believed to be a common mode of star formation in the early Universe. Thus, these nearby clusters provide critical insight into the nature of star formation over cosmic time and the starburst phase of galactic evolution. We leverage high resolution ALMA observations of the molecular emission from individual cluster regions in order to analyze the evolution and impact these clusters have on their surroundings over their lifetimes. We compare observations of multiple lines from several abundant dense gas tracers (HCN and HC3N), examining emission from both lower-energy rotationally-excited transitions which trace less dense gas in the cluster environment and higher-energy vibrationally-excited transitions from the dense and dusty inner cores. By comparing the gas motions in these two regions, we isolate signatures of both gas outflow and inflow on cluster-scales that allow us to better understand the life cycle of massive star clusters and how they contribute to large-scale winds that shape the evolution of entire galaxies.

02 - Poster: Assessing photo-z accuracy and parameter estimation with limited photometric bands using CIGALE.

Vanessa Porchet

Queensland University of Technology

Redshifts are crucial for extragalactic and cosmological studies. Upcoming wide-field surveys, such as the Evolutionary Map of the Universe (EMU), will catalogue millions of sources, making spectroscopic follow-ups unfeasible at scale. Though sensitive to band selection and availability, photometry yields redshifts (photo-zs) for fainter sources while optimising telescope time. Using the extensive FourStar Galaxy Evolution Survey and spectroscopic redshifts (z_spec) for calibration, we employ the Bayesian SED-fitting tool CIGALE to derive photo-zs up to z~3 and assess their accuracy with limited data. By systematically reducing bands, we compare NMAD values between full and reduced-band fits to identify the minimal bandset for reliable estimates. We then examine the impact on stellar mass and star formation history derivation by analysing deviations from best-fit mock analyses and apply our findings to crossmatched EMU datasets. We find that photo-zs from 6 well-spaced optical to mid-IR bands remain robust compared to full-band (> 27 bands) estimates, reaching accuracies of NMAD_full = 0.013 with η = 1.46% catastrophic errors and NMAD_6bands = 0.038, η = 2.55%. We derive reliable parameters using our minimal bandset, though our reduced framework performs best in a redshift range 0 < z < 1.5. I will discuss how these results optimise scientific return for single-point EMU radio sources with sparse overlapping data and outline the broader potential of minimal-band SED fitting.

03 - Poster: The origin of the Dense Core Mass Function

Alexandre Perroni

Institut de Planétologie et d'Astrophysique de Grenoble

The Initial Mass Function (IMF) describes the mass distribution of stars that form in a single molecular cloud. A key question is the universality of the IMF. The current paradigm is that the IMF originates from the dense core mass function (DCMF), the mass distribution of the dense cores that are, within molecular clouds, the regions that lead to protostars. However, if the universality of the IMF is likely, the universality of the DCMF remains highly debated; the direct link between DCMF and IMF is even questioned. My PhD work focuses on the role of molecular clouds turbulence in the formation of dense filaments and cores. More specifically, our aim is to explore the transition from supersonic to subsonic turbulence in the vicinity of dense filaments. To achieve this goal, we first build synthetic data cubes of CO emission from molecular clouds used to benchmark the centroid velocity technique used in turbulent studies (from 3D numerical MHD simulations). The emergent spectra result from the complex interplay between the CO abundance and velocity field along the line of sight. In a first step, our approach is based on a semi-analytical treatment of the radiative transfer and use simple prescriptions for the CO abundance based on state-of-the-art numerical models. In this Poster, I present the overall methodology and the resulting spectra obtained with HD and MHD simulations from the CATS and GALACTICA databases, and covering a range in sonic and Alfvénic Mach numbers.

04 - Poster: Using Wolf-Rayet regions as a unique laboratory to study star formation and stellar feedback

Fuheng (Eric) Liang

Heidelberg University

The onset of star formation from molecular clouds and the details of stellar feedback to the interstellar medium (ISM) are among the most important yet unresolved mysteries in galaxy evolution. Wolf-Rayet (WR) stars are the post–main sequence stage of high-mass stars, with stellar ages of 2-10 Myr. Thanks to such short lifetime, they are ideal sites to study star formation and stellar feedback. With the newly available (extended) sample of about 50 nearby galaxies from the PHANGS project observed by VLT/MUSE, this project systematically searches for WR regions defined by their distinct spectral features at physical resolutions of ~50 pc. Combined with multi-wavelength data from the PHANGS project, this catalogue facilitates the following studies: (1) to understand the properties and destruction timescale of the parental molecular clouds of WR regions; (2) to look for evidence for stochastic sampling of the initial mass function in star cluster SED modelling by using WR regions as a precise and accurate age timer; (3) to put constraints on pre-supernova feedback (in metallicity, pressure, temperature, density, etc.) and to reveal the ISM properties immediately before supernova explosion. This poster presents the catalogue construction and showcases explorative investigation in these directions.

05 - Poster: PAH Marks the Spot: Digging for Buried Star Clusters in Nearby Galaxies

Daniel Dale

University of Wyoming

Identifying and characterizing embedded star formation is a key goal for the Physics at High Angular Resolution in Nearby GalaxieS (PHANGS) project. Using JWST and HST imaging we have identified hundreds of deeply embedded stellar clusters in a sample of 11 nearby star-forming galaxies using both a Zooniverse-based by-eye approach as well as machine learning. The main criterion defining `embedded' in this study is visible in JWST near-infrared imaging and invisible in HST UV/optical imaging. I will present several facets of this study: the similarities and differences between the samples generated via the by-eye and machine learning approaches; how the machine learning identifications depend on the convolutional neural networks employed; the distributions of the cluster profiles, ages, masses, and extinctions and how they compare to those of samples of exposed stellar clusters; and the spatial correlations between embedded clusters and the molecular gas as observed by ALMA.

06 - Poster: The disk-halo interface of the edge-on galaxy NGC891: discovery of a 1.3kpc thick molecular gas disk

Daniel Jiménez-López

Observatorio Astronómico Nacional (OAN)

The halos surrounding spiral galaxies act as a bridge between the galaxy and the IGM. It is therefore of paramount importance to gain a deeper knowledge of the nature and kinematics of this medium. They host most of the baryonic mass in the Universe, and many authors point to SF- or AGN-driven feedback as one of the main mechanisms regulating the presence of baryons outside the galactic disks. In this work, we aim to reveal the internal structure and kinematics of the molecular gas using data obtained with HERA, with the IRAM 30m, of the CO (2-1) emission of NGC891. This non-starburst/non-AGN galaxy, which is quite similar in size and structure to the Milky Way, is the perfect target to study the vertical structure of the molecular gas on "normal" SFG disks, and a unique opportunity to study the origin of the baryonic material in galactic halos and the feedback-driven mechanisms that regulate this process. The CO images were compared with the Hα and HI maps of the Galaxy to understand the possible correlation with the star formation feedback in the disk and the HI distribution. The best fit results for the molecular gas distribution confirm the existence of a thin and a thick molecular gas disk, where the thick disk extends up to 1.36 kpc above the galactic plane and may contain up to ~25% of the total molecular mass reservoir. Dark dust columns appear to connect the inner disk to to the halo, suggesting supernova-driven outflows that expel the baryonic material.

07 - Poster: MUSE-ALMA Haloes: the baryon cycle traced by the molecular kinematics of HI-rich galaxies

Capucine Barfety

Max Planck Institute for Extraterrestrial Physics

The baryon cycle of galaxies manifests itself through the interplay of gas and stars in galaxies with their environment, describing the evolution of matter in these systems. To study the baryon cycle, the MUSE-ALMA Haloes project gathered multi-wavelength observations of galaxies associated with absorption features in the spectra of background quasars. In doing so, it creates a sample of galaxies unbiased by mass or star formation rates. This sample uniquely enables us to study simultaneously galaxies and their circumgalactic medium (CGM) in a comparatively less well-explored redshift range ($0.43 < z < 1.15$), spanning over four orders of magnitude in stellar mass ($8.0 < \log(M^*) < 12.4$). In this talk, I will present an analysis of the cold molecular gas kinematics of 13 of these galaxies and discuss the connections with neighbors and gas flows identified between galaxies and their surrounding CGM, a direct tracer of the baryon cycle.

08 - Poster: Two-point correlation analyses of the molecular gas structure down to GMC scale

Hao He

University of Bonn

The structure of molecular gas encodes key information about the assembly of gas and the triggering of star formation. In this study, we perform various statistical analyses to quantify the structure of molecular gas using PHANGS-ALMA CO(2-1) maps of 40 galaxies at a resolution of 150 pc. First, we use the homogenized GMC catalogs extracted from CPROPS to quantify the arrangement of gas above the giant molecular cloud (GMC) scale. We employ the two-point correlation function to quantify GMC clustering at different scales. We adopt a novel approach by using random source catalogs generated from different prior spatial density fields. We find that the clustering excess of GMCs is largely reduced (from 300% to 30%) if we choose a radially declining distribution instead of a uniform distribution, suggesting that a large fraction of sub-kpc GMC clustering stems from the large-scale molecular structure. With more realistic density fields, we find no significant evidence of a preferred clustering scale. We then perform stacking of GMC radial profiles to quantify the GMC structure below our resolution. In comparison, we also generate model images based on the CPROPS elliptical Gaussian model. We see a very good agreement between the data and our model up to a radius of ~200 pc. About 20% of the emission in the data is not captured by our model at a larger radius (~500 pc), which is likely the emission from faint GMCs below our sensitivity limit.

09 - Poster: Discrepancy between photoionization models and spatially resolved observations on kpc scales

Ziming Peng

The Chinese University of Hong Kong

Knowing gas-phase metallicity is essential for constraining the chemical evolution of galaxies. There are various methods used for deriving metallicity. Measuring auroral-to-strong-line ratios to derive electron temperature is a direct approach. We find that there are significant discrepancies between the metallicities derived from photoionization model and the direct metallicity derived from SDSS-IV MaNGA data. Also, we report the discovery that temperature, as measured through auroral-to-strong line ratios of O+, trends in reverse directions with strong-line metallicity in super-solar regime. The results are verified in the stacked spectra of both MaNGA and SDSS-Legacy. Notably, this phenomenon is not observed in other low-ionization ions, such as S+ and N+, which also probe electron temperature. This finding challenges the fundamental principles of the direct T_e method for metallicity measurement. The problem could be related with the poor kpc-scale resolution in the datasets used, warranting highly resolved spectroscopy observations to understand its origin and to correct photoionization models.

10 - Poster: The BarYon Cycle project (ByCycle): Uncovering the Universe's Hidden Baryons with Machine Learning

Nicolás G. Guerra Varas

ESO HQ

Around 90% of the baryons in the Universe lie in the circumgalactic and intergalactic medium (CGM & IGM) and remain significantly less understood than the matter associated with starlight, such as galaxies. In this talk, I will introduce the Baryon Cycle (ByCycle) project, an upcoming 4MOST-VISTA survey that aims to uncover these hidden baryons. Our survey will consist of high-resolution (R ~ 20000) spectra of a large sample (~1 million) of bright and distant quasars, which will reveal IGM and CGM gas found in the line-of-sight through absorption lines. I will present ongoing efforts on the development of machine learning models that will help us process the ~400 spectra that our survey will receive each night. These algorithms find, classify and characterize absorbers within these spectra. Only with such a setup will we be able to study how gas flows in and out of galaxies and their effect on their evolution in unprecedented statistical significance and detail. I will give an overview of the novel science that ByCycle will make possible, its potential impact on galaxy evolution studies, and how the community can benefit from it.

11 - Poster: The gas phase content and evolution of the circumgalactic medium

Daniel DeFelippis

University of Arizona

The baryon cycle is a key aspect of galaxy evolution that connects different objects and scales together, from individual stars within galaxies to gaseous structures in their surrounding halos. I will present recent work studying multiple aspects of the baryon cycle with different simulations. Using RAMSES zoom-in simulations, I studied the effects of cosmic ray feedback on the circumgalactic medium (CGM) of Milky Way progenitors. I found that the addition of this source of feedback resulted in cooler outflows and an increased covering fraction for certain ions (CIV and OVI) in the CGM, making the simulations more consistent with observations at z~1. This suggests that feedback from cosmic rays could be a crucial missing ingredient from larger galaxy formation codes. I also analyzed similar galaxy-halo systems from a subset of the IllustrisTNG simulation suite with a very high time resolution, allowing for detailed time-series analysis. I found that CGM gas experiences significant changes in many quantities like temperature and also mixes between different phases fairly often on ~200 Myr timescales, largely due to feedback from supernovae. Furthermore, over long enough (~1-2 Gyr) timescales, CGM gas evolves towards a similar state composed of a cold, dense, low-entropy phase at small radius and a hotter, more diffuse, high-entropy phase at large radius, indicating a relatively stable average population of CGM gas that emerges from various complicated evolutionary pathways.

12 - Poster: Exploring the Satellite Systems of Bulge-Less Galaxies: Insights from TNG50

Salvador Cardona-Barrero

Instituto de Astrofísica de Canarias

The stochastic nature of galaxy growth within the ΛCDM framework favors the formation of dynamically hot structures in the inner regions of galaxies, such as classical bulges. These structures may arise from early chaotic collapse or dynamical heating through galaxy-galaxy mergers. In this context, the existence of massive ($>10^{10}M_{\odot}$) disk galaxies with little or no bulge remains poorly understood. The specific formation pathways of these bulge-less disk galaxies shape not only their morphology but also the properties of their satellite populations. In this work, we use the cosmological hydrodynamical simulation TNG50-1 to analyze the distinct properties of the satellite populations of bulge-less galaxies and investigate how those properties are linked to their host morphology. Our analysis indicates that bulge-less galaxies tend to host fewer satellites than bulge-dominated galaxies and exhibit steeper luminosity functions. Moreover, their satellites display a preferential 3D alignment and are more centrally concentrated. These results suggest that the formation history of the host galaxy influences both the abundance and orbital properties of its satellite system.

13 - Poster: Photometric Characterization of Extended Globular Clusters in the Outer Halo of the Milky Way

Paula Díaz

University of Chile

The Milky Way outer halo contains both globular clusters (GCs) and dwarf galaxies. The key distinction between these two objects is the dark matter content. While dwarf galaxies are dark matter dominated, GCs' stars kinematics indicates that GCs are devoid of dark matter. For some time now, it has been reported that several outer halo GCs have stars beyond their King tidal radius, possibly attributed to either tidal tails or a diffuse stellar envelope. In the latter case, the origin of these stars and how they stay gravitationally bound to the cluster's center is currently unclear. A poorly explored model suggests that these diffuse stellar envelopes may be attributed to GCs embedded in dark matter halos and predicts the impact on the kinematics and photometric properties of the GCs. In this study, the primary goal is to assess the photometric prediction of the dark matter GC model by reliably establishing the nature of the extended stellar populations and its density profile slope behavior in five outer halo GCs through an analysis of their CMDs, proper motion data, luminosity functions and orbital characteristics.

14 - Poster: Investigating Gas Flows Through Anomalous HII Regions and Metallicity Patterns

Alejandro Olvera

Arizona State University

We present a resolved multi-wavelength study of 10 local Milky Way-type galaxies from the Deciphering the Interplay between the Interstellar Medium, Stars, and Circumgalactic Medium (DIISC; Borthakur et al. 2025, in prep) survey, focusing on gas flows and metallicity patterns. Using optical multi-object slit spectroscopy from the MMT 6.5m telescope, we observe >400 HII regions and measure radial metallicity gradients with the N2 and O3N2 indicators. We find both negative and flat gradients, with several HII regions exhibiting anomalously low or high metallicities. Some are also kinematically offset from local HI gas, with H-alpha velocity shifts up to 50 km/s. We interpret the metal-poor regions as evidence of pristine gas accretion from the circumgalactic medium, while metal-rich regions may result from fountain-driven enrichment. To test these scenarios, we apply the bathtub chemical evolution model, examining mass-loading factors and effective yields. Additionally, we measure a resolved Fundamental Metallicity Relation (rFMR), compare it with literature results, and discuss the role of gas flows in shaping this relationship. Our findings highlight the importance of resolved multi-wavelength studies in disentangling small-scale processes in galaxy evolution. By identifying anomalous star-forming regions, we provide new insights into how inflows and outflows regulate metallicity and star formation in L* galaxies, reinforcing the need for high-resolution spectroscopic surveys

15 - Poster: Connecting quasar winds to multiphase galactic outflows

Samuel Ward

CCA, Flatiron Institute

Active galactic nuclei (AGN) drive powerful, multiphase outflows into their host galaxies which are expected to play a key role in galaxy evolution. However, exactly how small-scale accretion disc winds couple to the ISM to drive these outflows remains an open question. In this talk, I will present our AGN in Clumpy DisCs (ACDC) simulations which feature a physically-motivated AGN wind model embedded in an idealised galaxy disc with a resolved ISM, manually distributed in a clumpy substructure. We find that the hot wind causes the cold ISM clumps to fragment and become entrained in the outflow as small cloudlets. This leads to an outflow that differs significantly from commonly-considered shell-like morphologies, which has important implications for observational studies seeking to characterise outflows and infer their impact on the hot galaxy. We also find that mixing between the AGN wind and ISM clouds produces X-ray emission that can be detected above the level from star formation with telescopes such as Chandra or AXIS. This could provide a complementary probe for the total volume of gas that the outflow has interacted with.

16 - Poster: Radio mode feedback on the cold gas reservoirs of highly accreting quasars

Anelise Audibert

Instituto de Astrofísica de Canarias

Low-to-moderate luminosity kiloparsec scale radio jets are starting to be recognized as potential drivers of multi-phase outflows and as relevant mechanisms for active galactic nuclei (AGN) feedback. In radio-quiet quasars, compact radio jets are associated with distinct morphological and kinematic features in the ionized and molecular gas, such as increased turbulence and outflowing bubbles. To investigate the impact of low-to-moderate power jets on the cold gas reservoirs of AGN, we present high-resolution ALMA CO(2-1) and CO(3-2) observations of a sample of 5 radio-quiet quasars at z~0.1. Spatially resolved molecular line ratio maps were used to constrain changes in gas excitation and outflows characterized using kinematic modeling. We compare the outflow, host galaxy, and jet properties, finding mass outflow rates lower than those expected from their AGN luminosities, while the outflow kinetic power can be driven by the combined jet power and bolometric luminosity of their hosts, depending on their coupling. Despite AGN feedback not depleting the gas reservoirs and quenching global star formation, our observations reveal that the radio jets/winds disturb the cold gas morphology and kinematics within the central kiloparsecs of galaxies. Our findings provide evidence that the coupling between jets and the interstellar medium is relevant to AGN feedback, even in the case of radio-quiet galaxies.

17 - Poster: ALMA-FACTS: Variations in CO(2-1)/CO(1-0) Across Twelve Nearby Spiral Galaxies

Amanda Lee

Stony Brook University

We will present early results from a high-resolution analysis of the CO(2-1)/CO(1-0) line ratio, R21, across the disks of twelve nearby spiral galaxies. We use new ALMA CO(1-0) observations from the Fundamental CO(1-0) Transition Survey (FACTS), and re-image CO(2-1) data from PHANGS. Higher ratios suggest higher densities and temperatures. The sample includes barred and unbarred, and flocculent galaxies. We find that R21 varies systematically as a function of structure. The barred spiral galaxies follow a general trend: R21 is high in the center, low along the bar, increases at the bar ends, and then declines towards the outskirts of the disk. R21 in unbarred galaxies fluctuate along the spiral arms. The barred galaxies also have spiral arms beyond the bar, which show similar fluctuations. The gas around HII regions typically have higher ratios. These results show that R21 varies systematically as a function of galactic structure and star formation activity, which should be taken into account when we interpret the relation between gas and star formation.

18 - Poster: Understanding the Role of Feedback in Star Formation Quenching: Insights from MaNGA Data

Daudi Mazengo

ESO/UDOM

Quenching of star formation remains a central challenge in galaxy formation and evolution studies. While stellar and AGN feedback are known to play a crucial role in regulating star formation, key questions remain: when, where, and how is the energy from feedback injected to suppress or enhance star formation? To address these questions, we analyze MaNGA data in combination with ancillary radio and X-ray observations to identify galaxies with ongoing nuclear activity. By using SDSS galaxy group catalogs, we distinguish between central and satellite galaxies and probe the host halo mass, providing a comprehensive view of the environment's influence on star formation. We investigate the relationship between star formation activity, the presence of AGN, and gas supply from the surrounding medium to understand where and how feedback energy might be released. To explore when feedback impacts star formation, we also incorporate state-of-the-art hydrodynamical simulations, reconstructing the AGN and star formation histories of synthetic galaxies to reveal the timing of feedback events. This approach aims to shed light on the complex mechanisms governing star formation quenching and the role of feedback in galaxy evolution.

19 - Poster: GMC Identification using 7.7-micron PHANGS-JWST Observations at 5-30 pc Physics Scales.

Zein Bazzi

Argelander-Institut für Astronomie

In this presentation, we analyze dust clouds identified in 7.7-micron images of 66 galaxies at 5-30 pc physical scales from the Physics at High Angular Resolution in Nearby GalaxieS (PHANGS) JWST survey. Using a spectral clustering algorithm based on dendrogram analysis (SCIMES; Colombo et al. 2015), we compare these dust clouds to those identified in Carbon Monoxide (CO) emission. The dust clouds exhibit molecular surface densities and properties similar to CO-identified clouds when a 7.7 micron-to-CO linear conversion is applied (Chown et al. 2024). However, low surface-density clouds are predominantly found in interarm regions, where they may correspond to either molecular regions undetected in CO observations or diffuse atomic components of the ISM. With over 150,000 clouds, this is the largest extragalactic cloud sample to date. We will discuss the advantages, limitations, and challenges of such an identification approach, particularly given the lack of a velocity component for the clouds in such observations.

20 - Poster: HI-selected dark sources and low surface brightness galaxies

Tamsyn O'Beirne

ESO

Our understanding of galaxy evolution is coupled to those galaxies that historically have been observable, but it is only in recent years that we have had the technology to detect optically dark and low surface brightness galaxies in large numbers. It is challenging to search for these sources just using optical data. However, those that are sufficiently gas-rich can be detected in neutral atomic hydrogen (HI) surveys, and we now have the resolution to do optical cross matching. We examine the optical counterparts of the 1829 HI detections in three pilot fields in the Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY) using data from the DESI Legacy Imaging Surveys DR10. With its significantly improved resolution compared to the previous large area HI surveys, HIPASS and ALFALFA, WALLABY is better able to localise the source of the emission and resolve tidal features. We find that 17% (315) of the detections are low surface brightness galaxies (LSBGs; mean g-band surface brightness within 1 Re of > 23 mag arcsec−2) and 3% (55) are dark. The LSBGs have low star formation efficiencies, and 75% of them had not been previously catalogued. Of the dark sources, 38 pass reliability tests, with 13 showing tidal interaction signatures, while 25 are candidates for isolated galaxies with high HI masses, but low stellar masses and star-formation rates. Studying dark and LSBGs allows us to learn more about the efficiency of the baryon cycle in these extreme galaxies.

21 - Poster: Empirical Metallicity Calibration for Diffuse Ionised Gas

Wai Kiu Ricky Wong

The Chinese University of Hong Kong

Gas phase metallicity measured by the strong line method has long been established for HII regions, for both empirical and theoretical calibration. However, similar empirical calibration is rather lacking for diffused ionised gas (DIG), hindering our ability to study the chemical evolution of a large part of the galaxies. Knowing metallicity of DIG empirically would also help us solve the puzzle on their ionization mechanism. We will present an empirical strong-line metallicity calibration for DIG. It is established using the spatial proximity to HII regions based on star-forming galaxies in the PHANGS-MUSE survey. We will also discuss the differences in properties of DIG at different galactic environments and as a function of proximity to HII regions.

22 - Poster: Sub-kpc scale gas density histograms and star formation in the nearby galaxy M83 using ALMA data

Ren Matsusaka

University of Tokyo

We investigate the relationship between molecular gas density structure, gas accumulation processes, and star formation at the sub-kiloparsec (sub-kpc) scale. A key tool for analyzing the properties of diffuse and dense molecular gas components is the gas density histogram (GDH), which represents the fractional distribution of gas density within a given region. The shape of the GDH can be divided into two components: the low-density log-normal (L-LN) component and the high-density log-normal (H-LN) component. We make the GDH in the face-on galaxy M83 (NGC 5236) using observations of 12CO(1–0). This allows us to explore the distribution of the L-LN and H-LN components at a 550 pc scale and their connection to spiral arms. Our results indicate that the mass of the diffuse and dense components (Mdif and Mden) varies along the spiral arms. Additionally, we find that the fraction of the H-LN component to the total gas (fH) changes significantly along the spiral arms. Furthermore, we examine the connection between GDH and star formation. We find that the surface density of the H-LN component follows the conventional correlation with the star formation surface density (SFR) at the 550 pc scale. In contrast, the surface density of the L-LN component shows only a weak correlation with SFR. These results suggest how molecular gas accumulates and transitions between different density states, ultimately influencing star formation in galaxies.

23 - Poster: A New Method for Measuring Star Formation Rate in NGC 1068 and Its Relation with Galactic Structure traced by 13CO/C18O

Yuzuki Nagashima

NAOJ

Molecular clouds where star formation occurs are affected by galactic structures. Understanding the spatial distribution of star-forming regions is crucial to understanding the interplay between clouds and the host galaxy. However, the conventional SFR derivation methods contain uncertainties that lead to significant over/underestimation. Here, we present a new SFR calibration method based on ionized gas tracers, with essential corrections for extinction, diffuse ionized gas (DIG), and thermal dust contamination.The key aspect of our new SFR measurement is that we can estimate the electron temperature, which significantly affects the derived SFR based on ionized gas tracers.We used a pair of 60-pc-resolution datasets of ionized gas tracers, Paα observed by HST, and free-free continuum observed by ALMA. We present a 60-pc-scale SFR map of the nearby typical spiral galaxy NGC 1068. Additionally, the high-resolution SFR map provides new perspectives (N13CO/NC18O(: CO isotope abundance ratio) vs SFR) on the star formation process by comparing the molecular gas mass distribution derived at the cloud scale. Our method provides a framework for future SFR studies, which can further be applied to a wider range of galaxies to investigate the relationship between star formation and galactic structure.

24 - Poster: High-Velocity Molecular Clouds in the Barred Spiral Galaxy M83

Maki Nagata

The University of Tokyo

Gas in a disk galaxy is generally rotation dominated. However, some can deviate from this rotation due to feedback from massive stars, as well as inflows of gas from external sources or galactic fountains. These high-velocity clouds (HVCs) may play a critical role in galaxy evolution, potentially triggering star formation through cloud-cloud collisions and contributing to material circulation within galaxies. In the MW, the edge-on view complicates comprehensive studies of such HVCs. Detecting HVCs in nearby face-on galaxies are therefore essential. In this study, we focus on the barred spiral galaxy M83, where high spatial resolution, high-sensitivity CO (1–0) data (Koda et al. 2023) are available. We identified molecular clouds using the astrodendro (Rosolowsky et al. 2008) algorithm and searched for clouds with velocities deviating by more than 50 km/s from the large-scale velocity field as HVCs. A total of 10 HVCs were detected—nine redshifted and one blueshifted—clearly highlighting an asymmetry in their velocity distribution. These HVCs have radius of 30 –80 pc, masses of 10^4–10^5 Msun, and velocity dispersions of 3–20 km/s, displaying a tendency toward higher velocity dispersion compared to other molecular clouds in M83. Most of HVCs do not overlap with the candidates of supernova remnants, and the energy needed to drive HVCs at such high velocities exceeds supernova energy. We thus claim that most HVCs found in this study are inflow from outside the M83's disk.

25 - Poster: Molecular Gas Reservoirs in Jellyfish Galaxies: Insights from ALMA JELLY

Matěj Bárta

Astronomical Institute of the Czech Academy of Sciences

Ram pressure stripping (RPS) significantly alters the molecular gas reservoirs of cluster galaxies, directly impacting their ability to form stars. As part of the ALMA JELLY collaboration, we analyze ALMA CO(2-1) observations of 28 nearby jellyfish galaxies at ~500 pc resolution. The sample spans a range of stripping stages and interaction geometries with the intracluster medium. We analyze the distribution of molecular gas, identifying asymmetries in its morphology and kinematics. Using kinematic modeling, we compare observed velocity fields of the remaining molecular discs to idealized rotating disc models, allowing us to isolate non-circular motions and kinematic disturbances induced by the RPS. Using supplemental multi-wavelength data (including MUSE/VLT and MeerKAT), we will also compare the characteristics and kinematic properties of different gas phases to better quantify the effects of RPS. This study aims to improve our understanding of how molecular gas is affected in cluster galaxies undergoing stripping and its implications for the regulation of star formation in dense environments.

26 - Poster: Die Hard: How Rejuvenation Cycles Shape Galaxies Today

Silvio Fortuné

USM / LMU

Our picture of galaxy evolution currently assumes that galaxies spend their life on the star formation main sequence (SFMS) until they may eventually be quenched. However, recent observations show indications that the full picture might be more complicated. To investigate this matter, I trace galaxies across cosmic time in the high-resolution cosmological hydrodynamical Magneticum simulation and find that a consistent evolution scenario along the SFMS until today is in fact rare. Indeed, a formation shaped by rejuvenation cycles on giga-year time scales is much more likely with the SFMS to be regarded rather a snapshot of star formation activity than an evolution track. Consequently, I find that most active and a significant fraction of quenched galaxies at z=0 have experienced rejuvenation cycles. Such a rejuvenation can even occur passively in a Milky-Way-like fashion with a low but constant star formation rate as the SFMS itself declines over time. Finally, I use this more refined view on star formation histories not only to relate them to the rates and geometry of their gas flows and the agreement with the bathtub model, but also to show how different forms of rejuvenation cycles leave characteristic imprints on stellar masses, metallicities and ages of present-day galaxies, as well as their radial distributions. This could prove a helpful tool to deduce formation histories of nearby galaxies as well as to formulate expectations for observable tracers.

27 - Poster: Revealing the ionized gas kinematics of typical z~4-6 galaxies using JWST NIRSpec IFU spectroscopy.

Diego Gomez-Espinoza

Universidad de Valparaiso

Studying galaxies in the early Universe is a key topic in modern astrophysics since these first galaxies are the building blocks of present day galaxies. In this talk, I will present preliminary results obtained from JWST/NIRSpec IFU observations towards eighteen z~4-6 galaxies taken from the ALMA Large Programs ALPINE and CRISTAL. The mid-infrared wavelength range of NIRSpec allows us to measure strong optical emission lines (in the rest frame), such as H-alpha, H-beta, [OIII]-5007A, and [NII]-6584A. These lines allow us to determine the properties of the ionise interstellar medium, including star formation rates, electron density, metallicities, and kinematics. I will present results focused on the 2D velocity fields of the ionized gas in the galaxies, traced by the H-alpha emission line, and how these properties compare to other galaxy samples at lower redshifts. These results will be confronted to the kinematics of the molecular gas, traced by the [CII]-158μm emission line, in order to reveal potential misalignments between the different phases of the ISM in these high-z galaxies

28 - Poster: The impact of minor mergers to galaxy mass assembly – insights from IllustrisTNG and JWST

András Péter Joó

Eötvös Loránd University, Doctoral School of Physics

Galaxy mergers play an important role in the assembly history of galaxies, yet their impact on mass evolution and star formation remains an open question. Large-scale cosmological simulations and recent JWST results have enabled a deeper investigation of how mergers shape the baryonic components of galaxies over cosmic time. Using IllustrisTNG simulations, we examined the mass growth and star formation history of galaxy mergers across redshifts $0 < z < 15$ and compared our findings with JWST observations. Our analysis of merger trees from the TNG100-1 and TNG300-1 simulation runs reveals that merger events are associated with mass growth and an increased star formation rate in descendant galaxies. In my talk, I provide a quantitative assessment of how minor mergers, where the mass ratio is below 1:10, contribute to mass assembly and star formation, highlighting their importance in galaxy evolution.

29 - Poster: The Extended Molecular Gas of Circinus and NGC 1097 as seen by APEX

Akhil Lasrado

Institute of Theoretical Astrophysics, University of Oslo

The extended molecular interstellar medium (ISM) is often witness to dynamically important events in the galaxy's evolutionary history such as outflows, inflows, tidal interactions, mergers, as well as dynamical structures affecting its current evolution such as large-scale bars and spiral arms. Studying the imprints of these processes in the diffuse, extended molecular gas is best achieved by a single dish telescope which can cover a large field of view with good sensitivity. In this work we present results from Atacama Pathfinder EXperiment (APEX) on-the-fly mode maps of two nearby galaxies: Circinus in the CO(3–2) line, and NGC 1097 in the CO(2–1) line, covering their full optical extents. We detect molecular gas at the largest extents seen for these galaxies yet, at upto 5' for Circinus, and 4'.5 for NGC 1097, and compute the total CO luminosities and corresponding molecular gas masses for both galaxies. We further analyze the large-scale gas kinematics through position-velocity diagrams and 3D tilted ring modelling using BBarolo. We detect notable features in both galaxies beyond their well-studied bright central regions: in Circinus we detect molecular gas embedded in a bar-like structure, and in NGC 1097, we observe tidal molecular gas structures likely involved in the interaction of NGC 1097 with the companion galaxy NGC 1097A. The presence of such previously unseen structures show promise for conducting future large-scale studies towards nearby galaxies with APEX.

30 - Poster: JWST LEGGOS – Probing the impact of tiny clumps on their host galaxies and the universe with lensing

Michael Florian

University of Arizona

The JWST program, LEGGOS (Lensing and Galaxy Growth: Observing Substructures), is comprised of NIRCam imaging and NIRSpec IFU spectroscopy on a sample of 8 strongly-lensed galaxies at redshifts from ~2.4 to ~3.6 (6 new targets, 2 archival), enabling detailed spectrophotometric modeling of around 200 unique clumps with a median clump magnification of about 20 and a maximum in the hundreds. First, I will discuss results of an image-plane search for clumps that may be leaking Lyman-continuum (LyC) emission. Understanding how LyC photons escape from galaxies is critical to understanding the reionization of the universe. Rivera-Thorsen et al. (2019) found that a single star-forming clump was responsible for the LyC emission in one gravitationally-lensed galaxy, the Sunburst Arc. The hunt is now underway for more examples with such high spatial resolution. The aim is to build a sample to study how the interactions between these substructures and their host galaxies enable ionizing photons to escape. I will report on the search for more LyC leaker candidates within the LEGGOS sample based on both photometric and spectroscopic diagnostics. However, image-plane studies like this only scratch the surface of what can be done with JWST observations of lensed galaxies. I will also discuss ongoing work to make robust source-plane measurements of clump properties through forward-modeling approaches and the eventual implications for galaxy mass assembly and evolution.

31 - Poster: Unveiling Chemical Structures in Edge-On Disk Galaxies

Michelle Ding

UNSW

The chemistry of galaxies encodes critical information about their star formation and evolutionary history. With the Milky Way consisting of distinct chemical and structural components, a key challenge lies in disentangling the relative contributions of in-situ star formation and ex-situ processes in shaping galactic disks. To address this, spatially resolved studies of the chemical and structural components of external galaxies are required. Using the VLT MUSE instrument, we investigate how stellar population properties vary with height above the galactic plane in external edge-on galaxies. In this talk, I will present age, metallicity, and alpha abundance maps for a subset of GECKOS galaxies, derived using two different methods. Specifically, we test the derived mean stellar population parameters from line strength versus full spectrum fitting. This is particularly important for edge-on galaxies with significant amounts of dust and star formation. I will further compare the results from both methods with predictions from a chemodynamic Milky Way model. Our research, combined with recent results from other highly resolved spectroscopic studies of nearby galaxies, will provide a more complete picture of how stellar populations shape the structural and chemical evolution of disk galaxies.

32 - Poster: Investigating Jet Rotation and Shock Physics in HH211 with NOEMA's PRODIGE Survey

Tristan Bachmann

University of Rochester

Protostellar jets are a key factor in stellar feedback mechanisms, both in the evolution of the protostar itself, and in regulating star formation in the surrounding region of the galaxy. We take HH211 as a case study, observing with NOEMA in several radio bands, and acquire data from several molecular tracers, namely 12CO, 13CO, C18O, H2CO, SO, SiO, and SO2. We analyze this data to determine the dynamics of the disk-jet interaction region, and jet-envelope interaction region, investigating the angular momentum transport, level of entrainment in the envelope by the jet, and shock properties of the bullets in the jet as they interact with the surrounding ISM. We also compare with magnetohydrodynamic simulations, using the FLASH code, and analyze the magnetic field structure in the disk and jet.

33 - Poster: High resolution polarization measurements in nearby galaxies in The Local Group L Band Survey

Timea Kovacs

MPIA

There is evidence that many processes in galaxies, including gas dynamics, galactic outflows, the propagation of cosmic rays, the star formation rate and the initial stellar mass function are all affected by the magnetic field of galaxies. Polarization observations of nearby galaxies with high angular resolution can help us study both the small and large-scale magnetic fields of galaxies, and provide important clues to how they develop. We present polarization data from the Local Group L Band Survey (LGLBS), a Very Large Array radio survey of the six closest, actively star-forming galaxies on the Northern Sky, providing the best-possible (using all array configurations), arcsecond-scale resolution (10-100 pc) at 1–2 GHz. Our sample includes M31, M33, and four dwarf galaxies (NGC 6822, IC10, IC 1613, WLM). Using this dataset, we can improve our understanding of the magnetic fields in nearby galaxies in high resolution. The diffuse polarized emission of the galaxies, and the rotation measure of polarized background sources behind these galaxies can provide insights into the magnetic field structure and strength of the galaxies. With approximately 40 background sources/deg2, this dataset will provide a better RM grid compared to previous studies. Furthermore, the total intensity maps can be used to estimate the total magnetic field strength, assuming equipartition. In this talk, we will present the first polarization maps of the galaxies at a few arcseconds resolution.

34 - Poster: Gas and Stellar Kinematics in the Circumnuclear Regions of Nearby Hard X-ray Detected AGNs

Ming-Yi Lin

University of Toledo

Studying gas and stellar kinematics in the circumnuclear regions of nearby AGNs at spatial scales of <10pc provides insights into how gas is influenced and transported toward the supermassive black hole (SMBH). We present the gas kinematics from cold molecular gas observed with radio interferometer and stellar kinematics derived from stellar absorptions in near-IR AO-assisted IFU data. Using spherically-aligned Jeans Anisotropic Modelling (JAM) on stellar kinematics, we construct a detailed mass model, consisting of V and Vrms. By comparing the cold gas kinematics with the mass model, we aim to directly test black hole accretion rate prescriptions (e.g., modified Bondi–Hoyle) at radii of ~100 pc around the SMBH. If a specific object has detected a broad gas outflow in the center, we also aim to constrain the mass outflow rate and kinetic outflow power.

35 - Poster: Massive double-exponential disk galaxies with outer, extended low surface brightness stellar disk

Suchira Sarkar

Inter-University Centre for Astronomy & Astrophysics (IUCAA)

The formation and evolution of the most massive (stellar mass = 10**11 solar mass) disk galaxies in the nearby universe represents many intriguing questions. One class of such galaxies are the giant low surface brightness galaxies. Several of them (e.g, Malin 1, UGC 1382, UGC 1378 etc) are observed to have a central high surface brightness exponential disk surrounded by a photometrically distinct, extended (R_d more than 10 kpc) low surface brightness stellar disk. Several mechanisms e.g., accretion of dwarf satellites in the outskirt of the host galaxy, interaction with another galaxy, or even secular evolution have been suggested to create such hybrid morphology. We aimed to build a sample of such massive double-exponential disk galaxies from cosmological simulations in order to understand the mass assembly process across cosmic time. We used IllustrisTNG50 data and performed 2D light modeling on the synthetic SDSS-g band images of disk galaxies (M_star>=10^11 solar mass) made from TNG50 data. We found 7 galaxies (12% of the parent sample) to show HSB plus extended LSB structure, similar to the observed counterparts. The simulated double-disk galaxies are found to lie in the green-valley region of the sSFR vs M_star plane and also satisfy Baryonic Tully-Fisher relation (Sarkar S., Saha K., arXiv:2409.20309). We aim to study the mass assembly process and the survival process of the outer faint envelope of these galaxies in the follow-up work.

36 - Poster: Deciphering Galaxy Disk Assembly through Stellar Counter-Rotation

Damir Gasymov

ARI

Understanding how galaxies assemble their baryonic components requires disentangling the relative contributions of in-situ formation and external accretion. One striking example of externally driven assembly is the presence of stellar counter-rotation (CR) disks, where a substantial fraction of stars in a galaxy rotate opposite to the older stellar disk. These CR disks were formed by the accretion of gas (wet mergers or cosmic filaments) with opposite angular momentum to the preexisting stellar component, providing a unique observational window into how external gas contributes to the buildup of galactic disks. Using data from the MaNGA SDSS survey, we have identified a diverse sample of 120 galaxies with CR disks (~2% of all early-type galaxies), spanning a wide range of masses, environments, and star formation histories. These systems offer a unique opportunity to study how external accretion, angular momentum redistribution, and mergers shape galaxy evolution. Some of the most intriguing examples are massive galaxies in dense environments, where the gas accretion is difficult or impossible. This talk will present the insights into how accreted gas contributes to the growth of new disks, shedding light on the interplay between external gas accretion, counter-rotation, and the baryon cycle in galaxy evolution.

37 - Poster: [CII] and [OIII] Emission in Early Galaxies: Connecting Simulations with ALMA and JWST Observations

Benedetta Casavecchia

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Recent observations with ALMA and JWST have revolutionized our understanding of galaxy formation and evolution at the Epoch of Reionization, revealing crucial insights into the interstellar medium (ISM) and the cold gas reservoirs of high-redshift galaxies (z > 5). In particular, emission lines such as [OIII] and [CII] provide powerful diagnostics to trace metal enrichment, stellar feedback, and the molecular gas budget—the fundamental fuel for star formation. However, accurately modeling these emission lines within cosmological simulations remains a major challenge due to the complex interplay of physical processes across multiple scales. To address this, we introduce two complementary state-of-the-art hydrodynamical simulations: COLDSim, which incorporates time-dependent non-equilibrium chemistry to track the evolution of H I, H II, and H_2, and SPICE, which we use to model [OIII] line emission within radiation-hydrodynamical frameworks. Our [CII] modeling reveals that while neutral atomic hydrogen (H I) dominates the [CII] emission, this transition remains a key tracer of molecular hydrogen (H_2) mass, allowing us to constrain the cold gas budget from z = 6 to z = 12. While, by simulating [OIII] at 88 μm, 5008 Å, and 4960 Å, we explore the impact of different stellar feedback mechanisms on the mass-metallicity relation and the [OIII] luminosity function, highlighting the role of bursty versus smooth feedback in shaping ISM conditions.