Monday, Sept. 9

VESTIGE: A Virgo Environmental Survey Tracing Ionised Gas Emission (Invited)
Alessandro Boselli

I will introduce the VESTIGE survey, a blind, narrow-band Halpha imaging survey carried out with MegaCam at the CFHT (2017-2019 French-Canadian Large Program) to map the whole Virgo cluster region up to one virial radius. This survey has been designed to study at an unprecedented sensitivity (SHa ~ 2 x 10^{-18} erg sec^{-1} cm^{-2} $arcsec^{-2}$) and angular resolution (< 1 arcsec) the effects of the environment on cluster galaxies through the observation of the ionized gas component, ideal tracer of an ongoing perturbation. I will summarize the first results obtained after the first observing semesters based on the analysis of the core of the cluster and of some representative objects undergoing different kind of perturbations.

The Wolfe Disk (Invited)
J. Xavier Prochaska

I will review our series of successful programs to dissect the interstellar medium of distant, star-forming galaxies with the Atacama Large Millimeter Array (ALMA). In particular, I will discuss surveys of the set of HI-selected galaxies known as the damped Lya systems (DLAs). We resolve, in part, a decades old struggle to identify the galactic counterparts of these DLAs and thereby place them firmly in the modern picture of galaxy formation. I will also highlight high spectral and spatial resolution observations of the Wolfe Disk, a z~4 galaxy with a Milky Way-like rotation curve.

Exploring Quenching Mechanism via Gas Content
Yingjie Peng

Identifying and understanding the physical mechanisms responsible for star formation quenching are key challenges in modern astronomy. Star-forming galaxies can be quenched by internal mechanisms (e.g. AGN feedback, bulge formation) and/or external mechanisms (e.g. various environmental effects). Different quenching mechanisms can work at different stellar masses and at different epochs. I will show new evidences that in the nearby Universe the vast majority of the massive, quiescent, central disk galaxies have a surprisingly large amount of cold atomic hydrogen gas, surprisingly similar to star-forming galaxies, but with significantly reduced molecular gas content and lower dust content. This hence provides critical constraint on the physical mechanism of quenching. These new observation results are then compared with the latest hydrodynamic simulations, which indicates that the kinetic winds driven by the black hole may play a key role in quenching.

Massive Quiescent Disk Galaxies Have a Surprisingly Large Atomic Gas Reservoir
Chengpeng Zhang

Massive quiescent galaxies living in hot haloes are commonly believed to be gas-poor. Here we show from multi-wavelength sky surveys that in the nearby Universe the vast majority of the massive, quiescent, central disk galaxies have a surprisingly large amount of cold atomic hydrogen (HI) gas, similar to star-forming galaxies. Both types of disk galaxies show identical symmetric double-horn HI profiles, indicating similar regularly rotating HI disks. Relative to their star-forming counterparts, massive quiescent central disk galaxies are quenched because of their significantly reduced molecular gas content and lower star formation efficiency. The quenching of their star formation is closely related to the buildup of bulge, bar induced activities and low-luminous AGN feedback.

Starvation as the Primary Quenching Mechanism in Galaxies
James Trussler

Star-forming galaxies can in principle be transformed into passive systems by a multitude of processes that quench star formation, such as the halting of cold gas accretion (starvation) or the rapid removal of gas in AGN-driven outflows. However, it remains unclear which processes are the most significant, primary drivers of the star-forming–passive bimodality. We address this key issue in galaxy evolution by studying the chemical properties of 80,000 local galaxies in SDSS DR7. We find that passive and green valley galaxies typically have substantially larger stellar metallicities than star-forming galaxies of the same stellar mass, indicating that galaxies usually undergo significant metal enrichment during the quenching phase. By comparing the observed stellar metallicity difference between star-forming and passive galaxies with the predictions from gas regulator models, we find that the star-forming progenitors of local passive galaxies quenched primarily through starvation over a timescale of 2 Gyr. Outflows played a minor role in quenching the progenitors of massive galaxies, but were of increasing importance in quenching the progenitors of low-mass (log [M*/Msol] < 10) passive galaxies. Furthermore, we find that local green valley galaxies have typically been quenching through starvation for 3.5 Gyr, indicating that galaxies in the local Universe quench more slowly than their counterparts at higher redshift. Finally, we also analyse the spatially-resolved spectra from the MaNGA galaxy survey, which offers excellent spatial coverage out to 2.5 effective radii. By determining how the stellar metallicity difference between star-forming, green valley and passive galaxies varies with galactocentric distance, we aim to address how quenching operates on sub-galactic scales.

Mapping Gas and Dust in Nearby Galaxies
Cheng Li

Integral field spectroscopy (IFS) surveys provide spatially resolved measurements of both stellar and dust content in samples of galaxies. CO mapping add similar measurements of the molecular gas content. I will present joint analyses of IFS from CALIFA and MaNGA and CO mapping from CARMA-EDGE for a sample of nearby galaxies. By applying a new technique of measuring dust attenuation curves from full spectral fitting, we have obtained dust extinction map and radial profile for each galaxy in our sample. We're thus allowed to link the star formation history, molecular gas mass and dust attenuation of individual regions in a galaxy with its global properties, internal structure and external environment. I will show how these analyses have improved our understanding of the star formation quenching in low-z galaxies.

Role of Gas Fraction and Star Formation Efficiency in Galaxy Quenching
Joanna Piotrowska

Understanding the physics behind galaxy transition to quiescence is one of the most important questions in the field of galaxy formation and evolution. In order to differentiate between different proposed mechanisms, we use an indirect method to estimate gas masses for 62,000 SDSS DR7 galaxies. To achieve this, we infer gas column densities from dust mass densities as traced by extinction, applying a metallicity correction to account for varying dust-to-metal ratios. We find that both gas fraction and star formation efficiency (SFE) decrease as we move away from the star forming main sequence (MS) for all galaxy masses. We further show that both quantities correlate similarly strongly with the departure from the MS, implying the need for any physical model of quenching to invoke a change in both gas fraction and SFE. Only few models to date predict efficiency to be a significant driver of transition to quiescence, with the most appealing one suggesting stabilization of molecular clouds against collapse by tidal torques from the central bulge. Our results call for a better understanding of processes driving the decrease in star formation efficiency which received relatively little attention in the theory of quenching until now.

Tracing the ISM in Galaxies via Extinction: The High Resolution View from PHANGS
Christopher Faesi

Dust is ubiquitous in galaxies near and far. In addition to attenuating the ultraviolet and optical light from galaxies, dust via extinction measurements serves as an alternative and potentially powerful tracer of the dense interstellar medium independent from molecular line or dust emission diagnostics. We are leveraging the Physics at High Angular Resolution in Nearby Galaxies (PHANGS) MUSE 1” resolution observations to measure for the first time the Balmer decrement extinction at the molecular cloud scale (< 100 pc) across the disks of about 20 nearby star-forming galaxies. By comparing with matched resolution PHANGS ALMA CO (2-1) data, we show that extinction and CO emission are well-correlated at A_V > 1 even at the cloud scale. Additionally, our high sensitivity allows us to recover extinction where CO is not present, providing a potential tracer of atomic and CO-dark molecular gas in the diffuse regions of galaxies. We also investigate the scatter in the A_V - CO relation, which reveals cloud-scale differences in the gas and dust properties as well as geometric effects.

Dust Emission and Environment of the Most Distant Quasars at 5.6 < z < 7.1
Qiong Li

The first generation massive z ～ 6 quasars imply the history of galaxy and our Universe close to the epoch of cosmic reionization. Our group observed submillimetre continuum of 54 high redshift quasars recently discovered at 5.6 < z < 7.1, using the Submillimetre Common-User Bolometre Array-2 (SCUBA2) on the James Clerk Maxwell Telescope (JCMT). 20/54 bright sources are detected with a typical 850μm rms sensitivity of 1.2 mJy beam−1 (4～5 mJy, at > 3.5σ). The new SCUBA-2 detections indicate FIR luminosities of $10^{12\text{-}13}$ $L_\odot$, implying extreme star formation rate $10^{2\text{-}3}$ $M_\odot$ yr^{-1} in the quasar host galaxies. Compared with z = 2 ～ 5 samples, the

FIR and AGN bolometric luminous quasars (LFIR < 10^{13} $L_\odot$) are lack at $z \sim 6$. But the median optical-to-FIR between $z \sim 2.1$ and 6 do not evolve much. The optical/NIR spectral of these objects show a large fraction of weak emission line feature, which may relate to different sub-phases of the central AGNs. SCUBA2 survey indicates the sub-mm detections tend to have weaker UV emission line compared to the non-detections. But far-infrared properties have no correlation with weak line feather in physics. These WLQs at $z \sim 6$ have more active star formation probably triggered by galaxy merger. They may be the young AGN-galaxy system, in which BLR is starting to develop slowly and have some unusual properties. We also discovered overdensities of submillimeter galaxies (SMGs) in the nearby fields of 9 sources, which is consistent with previous overdensities of galaxies with deep optical imaging around $3<z<5$ quasars. The cumulative number counts of the average stacked z~6 sample is similar to that of the blank field. This may be because the sub-millimeter observing can only detect the infrared bright sources; and most of weaker sources have been omitted in this survey.

Where Galaxies Form Stars: a Multiwavelength Study of Resolved Star Formation Activity in the Past 10 Gyrs.
Laura Morselli

Spatially resolved studies of galaxy properties are critical in understanding how they grow their stellar mass and experience a morphological transformation from pure disks to bulge- dominated systems, thus unveiling one of the fundamental piece of the puzzle of galaxy evolution. The existence of the Main Sequence of star forming galaxies (MS, Noeske et al. 2007, Speagle et al. 2014), a tight relation between the

galaxy stellar mass ($M\star$) and its star formation rate (SFR), indicates that galaxies

build their stellar mass mainly through the accretion of cold gas from the host dark matter halo in a steady-mode scenario, thus dominated by secular processes (e.g. Daddi et al. 2010). I will present a compilation of studies of spatially resolved properties (in particular stellar mass, star formation rate, and dust content) based on different photometric and spectroscopic data at different redshifts (from z~0 to z~1.5), exploiting very recent surveys like MaNGA, DUSTPEDIA and a combination of 3DHST with HDUV observations. Such incredible dataset allows us to draw a clear picture of galaxy growth and give hints on how they switch off their star formation activity. The presentation will include the results of Morselli et al. (2019), as well as two papers in preparation.

Top-heavy IMF Found in Dusty Starburst Galaxies across Cosmic Time
Zhiyu Zhang

Initial distribution of stellar masses – the stellar initial mass function (IMF) – in order to extrapolate from the star-formation rate (SFR) measured for typically rare, massive stars to the total SFR across the full stellar mass spectrum. The shape of the stellar IMF in various galaxy populations underpins our understanding of the formation and evolution of galaxies across cosmic time. Classical determinations of the IMF in local galaxies are traditionally made at ultraviolet, optical and near-infrared wavelengths, which cannot be probed in dust-obscured galaxies, still less so in distant starbursts selected at submillimetre wavelengths, exactly the type of galaxies for which galaxy evolution models often predict an IMF biased towards massive stars. The 13C/18O abundance ratio in the cold molecular gas – which can be probed via the rotational transitions of the 13CO and C18O isotopologues – is a very sensitive index of the IMF, with its determination immune to the pernicious effects of dust. We determine this IMF-type index for a sample of four dust-enshrouded starbursts at high redshifts, with ALMA observations, finding unambiguous evidence for a top-heavy stellar IMF in all of them (Zhang et al. 2018, Nature, 558, 260). A globally low 13CO/C18O ratio for all our targets and local starbursts – alongside a well-tested, detailed chemical evolution model benchmarked on the Milky Way – implies that top-heavy IMFs are inevitable for starburst events compared to ordinary star-forming spiral galaxies. I will also present our new results of ALMA follow-up observation.

The Interstellar Medium in High-redshift Strongly Gravitational Lensed Galaxies
Chentao Yang

Lensed SMGs. The boosted angular resolution and brightness of the lensed SMGs opens new exciting opportunities for observing the interstellar medium in these exceptional objects. We have thus carefully selected a sample of the brightest strongly lensed SMGs based on the Herschel-ATLAS sample. Using IRAM telescopes, we observed multiple transitions of the CO lines and analysis the physical conditions of the molecular gas. The first multiple transitions of the submm H2O line survey at high-redshift was also conducted within our sample. Through these lines, we have studied the properties of the far-IR radiation fields that they trace primarily, which provide us new constraints of the warm dense, extreme dust-obscured regions. ALMA 0".2-0".4 follow-up of one of the brightest sources (G09v1.97) in our sample shows very well agreement of the spatial distribution and kinematics between the CO(6-5), H_2O(211-202) and H_2O^+(202-111) lines. Interestingly, this merger shows a mismatch between the cold-dust continuum peak and the peak of the line emissions, suggesting a significant amount of cold gas is in the interacting region, similar to the local merger prototype, the Antennae Galaxies. In parallel, we have conducted a series of line surveys in 3mm and 2mm bands with NOEMA and ALMA, which resulted in detections of a rich family of molecules including HCN, HCO^+, CCH, 13CO, C18O, C17O, C18O, CS, NH2, H2O, H3O+, in which many of them were first detections at high redshift. The rich detections of molecules in multiple transitions enable us for the first time to have a unprecedented detailed view of the astrochemical process and reveal rich information about the physical properties and chemical compositions of the molecular gas, as well as the properties of the radiation fields that dominated by UV photons, X-rays and cosmic rays.

Volumetric Star Formation Laws of Disc Galaxies
Cecilia Bacchini

Star formation laws are fundamental relations between the gas content of a galaxy and its star formation rate (SFR) and play key roles in galaxy formation and evolution models. Generally, the Kennicutt law is advocated to link the surface densities of SFR and gas ($HI+H_2$) with a sharp drop in the star formation efficiency (SFE) at low surface densities, but it is still unclear if a more fundamental correlation exists for the volume densities. We present new empirical star formation laws of disc galaxies based on volume densities. Assuming the hydrostatic equilibrium, we calculated the radial growth of the thickness of gaseous discs in 12 nearby star-forming galaxies. Thus, we could convert the observed surface densities of gas and SFR into the de-projected volume densities. We found a tight correlation with slope between 1.3-1.9 involving the volume densities of gas and SFR with a significantly smaller scatter than the Kennicutt law and no change in the slope over five orders of magnitude. Our result suggests that the slope break of the Kennicutt law is due to the disc flaring rather than to a drop in the SFE. Surprisingly, we discovered an unexpected correlation between the HI and SFR volume densities, indicating that atomic gas is a good tracer of the cold star-forming gas, especially in low density HI-dominated environments. In order to further test these correlations, we used gas and SFR measurements in the Milky Way (MW). Indeed, our Galaxy is a unique place where one can observe both the gas 3D distribution and the vertical structure of the youngest stars, which can be used to estimate the SFR volume density. We found that our volumetric star formation laws are valid in the MW, indicating that they may be universal for star-forming galaxies.

Poster Talks, Monday 13:30-14:00

Dirt-cheap Gas Scaling Relations: Using Dust Absorption and Galaxy Size to Predict Gas Masses for Large Samples of Galaxies
Hassen Yesuf

We reanalyze the GALEX-Aricebo-SDSS Survey (GASS) data. We apply novel survival analysis techniques to investigate the relationship between a number of properties of galaxies and their atomic and molecular gas mass, with the aim of devising efficient, effective empirical estimators of the cold gas content in galaxies that can be applied to large optical galaxy surveys. The dust attenuation, AV, and the stellar half-light radius of the galaxy, R50, are the two best secondary parameters that improve the primary relation between the gas mass and the star formation rate (SFR). We fit multiple regression to summarize the median, mean, and the 0.15/0.85 quantile multivariate relationships between the gas mass, SFR, AV and/or R50. We find that AV of both the continuum and nebular emission show significant partial correlations with molecular gas mass, after controlling for the effect of SFR. The partial correlation between AV and atomic gas mass, however, is weak. This is expected because in poorly dust-shielded regions molecular hydrogen is dissociated by far-ultraviolet photons. We also find that R50 shows significant partial correlations with both atomic and molecular gas masses. This hints at the importance of environment (e.g., galacto-centric distance) on the gas content of galaxies and the interplay between gas and SFR. Our new scaling relations can be used to estimate atomic and molecular gas masses within a factor of 2-3 for large samples of galaxies.

Ram-pressure Stripping in the Semi-analytic Models
Lizhi Xie

I will present a state-of-art semi-analytic model with explicit treatment of environmental effects on gas. Environment plays an important role in the evolution of satellite galaxies. A satellite galaxy suffers several kinds of environmental effects. It can stop accreting gas, and be disturbed by encountering intra-cluster medium. I use the model to quantify how different environmental effects influence the passive fraction and gas properties of satellite galaxies, and the dependence on stellar mass and halo mass. I will further discuss comparisons with gas surveys of galaxies in cluster haloes.

Estimating Dust Attenuation from Galactic Spectra
Niu Li

We develop a method to estimate the dust attenuation in galaxies from full spectral fitting of galactic spectra. Motivated from previous studies, we separate the small-scale features from the large-scale spectral shape, by performing moving average method to the observed spectrum. One important advantage of this method is that estimation of dust attenuation is independent of the shape of theoretical dust attenuation curves. We have done a series of tests on a large set of mock spectra and show that our method is able to recover the input dust attenuation accurately, although the accuracy depends on signal-to-noise ratio. We have applied our method to a sample of edge-on MaNGA galaxies with dust lane features, deriving their dust extinction map as well as dust-free images in g, r, and i bands. These galaxies show obvious dust lane features in their original images, and the features largely disappear after we have corrected in the dust extinction. The vertical brightness profiles of these galaxies become axis-symmetric and can be well fitted by model.

Molecular Gas in Face-On Star-Forming Low Surface Brightness Galaxies Based on APEX CO (2-1) Observations
Tianwen Cao

We observed the CO (2-1) spectral line in four nearby face-on star-forming low surface brightnessgalaxies (LSBGs) using the PI230 receiver on the 12m APEX telescope. These galaxies have been selected from a 111 star-forming LSBGs sample based on the Hα observation (Du et al. 2015). Three galaxies (AGC 110398, AGC 188845, and AGC,4528) exhibit CO (2-1) emission above 5σ level, with dispersions～182-236 km/s, with no detection in one LSBG (AGC 245576). Within the APEX beam area (～22”), these galaxies show molecular gas masses of $1.71\text{-}4.32\times10^{8}$Msun. We obtain that from normal to massive LSBGs, the logarithm of H2 surface density is inversely proportional to the absolute B-band magnitude with a slope of -0.273(±0.059), close to the empirical slope of 12+log(O/H) to absolute B-band magnitude (Arimoto et al. 1996). However, the metallicity is not the only factor affecting this trend. The star formation efficiency (SFE) of four LSBGs is lower than the one predicted by the Kennicutt-Schmidt Law. We also propose the APEX for another 30 hrs to observe more data for this sample.

Bayesian Modelling and Analyzing Galaxy Spectra with BIGS
Shuang Zhou

The stellar continuum and gas emission lines are complementary compositions of galaxy spectra. We develop a Bayesian inference code BIGS to model and analyze galaxy spectra and apply it to the IFU data-cubes of galaxies in MaNGA to infer various galaxy properties. We analyze a sample of MaNGA early type galaxies and find correlations between the initial mass functions and metallicity of stars, which is thought to be related to the thermal states of the star birth clouds. In addition, we study the SFHs of a sample of low mass dwarfs in MaNGA, and we find significant old stellar populations hidden behind bright young stars. We further study whether environment effects can change the SFHs in galaxies and how the SFHs vary within a single galaxy and between different galaxies. As the SFHs of galaxies are linking to the gas cycle and stellar/AGN feedback, the gaps between SFHs from hydro simulations and observations provide additional constrains on how those mechanism works.

Dust Geometric Distribution in Nearby Disk Galaxies
Jiafeng Lu

By analyses spectrum of 150000 disk galaxies in SDSS, we find a difference between extinction of emission and extinction of continuum. Then we give a quantitative estimation of dust geometry to explain it.

Tuesday, Sept. 10

Star formation and dust obscuration in galaxies: a unversal link across cosmic time
Xianzhong Zheng

The cosmic dust emission accounts for half of the extragalactic radiation background. How dust obscures star formation in galaxies across cosmic time remains to be understood. We find that dust obscuration (IRX=L_IR/L_UV) of star-forming galaxies obeys an empirical relation, jointly determined by IR luminosity, galaxy size metallicity and axial ratio. This empirical relation also holds for distant SFGs out to z = 3 in a population-averaged sense, suggesting it to be universal over cosmic time. Differing from previous understanding, our results reveal that stellar mass is not a determining parameter to IRX, and IRX approximately increases with L_IR/Re^[1.3-1.5], instead of L_IR=Re^2 (i.e., surface density). However, dust obscuration traced by Balmer decrement (Ha/Hb) does rely on stellar mass. The discrepancy relies on the SSFR surface density. Our finding of the universal relation of dust obscuration in SFGs can be used as a key scaling relation to constrain galaxy chemical evolution models.

Cold Interstellar Medium in z=2.49 Protocluster Galaxies
Minju Lee

We present ALMA observations of two CO (CO (4-3) and CO (3-2)) and the atomic carbon line ([CI](1-0)) toward star-forming galaxies associated to a protocluster at z=2.49 to understand galaxy evolution in the context of large scale structure formation. The galaxies are selected as H-alpha line and/or sub-mm continuum emission and those with stellar masses of >3e10 Msun are mostly located on the main-sequence. In the first half of the talk, we will present the measurements of the cold gas content based on a dozen individual detections and stacking analysis from the CO and [CI](1-0) lines, respectively, and compare with field populations. The second half of the talk will focus on one gas-rich (fgas~0.8) galaxy in the protocluster, using the CO (4-3) observations observed at 0”.3 (~2.4 kpc at z=2.5) that allows us to analyze the gas kinematics. We find that the galaxy is explained by an exponential, rotating disk.

While these are one of the first measurements to give an insight into galaxy evolution in different environments at high redshift, we conclude that larger volume observations are needed for better statistics.

Star Clusters as the Engines of Ionization in Local HII Regions as a Tool to Calibrate Photoionization and Star Models
Kathryn Grasha

Integral field spectroscopy with instruments such as MUSE provide an extraordinary dataset to study the resolved spatial and spectral properties of ionized HII regions in nearby galaxies. Having self-consistent stellar tracks and atmosphere modeling are crucial to accurately interpret observations of HII regions. To date, only a handful of stellar evolution models are available and they all use the same metallicity abundances. We know now that the assumed metallicity abundances greatly impacts the relative scaling of the lines ratios for the HII regions, and hence, the input elemental abundances will have a non-insignificant on the resulting parameters, such as metallicity, geometry, temperature, and ionization parameter. We now have empirical actual abundance sets that we use to create stellar models that are physically accurate and self-consistent with their stellar atmosphere modeling. We will present the impact of the different assumed elemental abundances has on the observable spectral energy distributions.

A New Method to Measure Star Formation Rates in Active Galaxies Using Mid-infrared Neon Emission Lines
Mingyang Zhuang

The star formation rate (SFR) is one of the most fundamental parameters of galaxies, but nearly all of the standard SFR diagnostics are difficult to measure in active galaxies because of contamination from the active galactic nucleus (AGN). Being less sensitive to dust extinction, the mid-infrared fine-structure lines of [Ne II] 12.81 μm and [Ne III] 15.56 μm effectively trace the SFR in star-forming galaxies. These lines also have the potential to serve as a reliable SFR indicator in active galaxies, provided that their contribution from the AGN narrow-line region can be removed. We use a new set of photoionization calculations with realistic AGN spectral energy distributions and input assumptions to constrain the magnitude of [Ne II] and [Ne III] produced by the narrow-line region for a given strength of [Ne V] 14.32 μm. We demonstrate that AGNs emit a relatively restricted range of [Ne II]/[Ne V] and [Ne III]/[Ne V] ratios. Hence, once [Ne V] is measured, the AGN contribution to the low-ionization Ne lines can be estimated, and the SFR can be determined from the strength of [Ne II] and [Ne III]. We find that AGN host galaxies have similar properties as compact extragalactic H II regions, which indicates that the star formation in AGN hosts is spatially concentrated. This suggests a close relationship between black hole accretion and nuclear star formation. We update the calibration of [Ne II] and [Ne III] strength as a SFR indicator, explicitly considering the effects of metallicity, finding very good relations between Ne fractional abundances and the [Ne III]/[Ne II] ratio for different metallicities, ionization parameters, and starburst ages. Comparison of neon-based SFRs with independent SFRs for active and star-forming galaxies shows excellent consistency with small scatter ($\sim$ 0.18 dex).

Interstellar Dust and Gas at Low Metallicity (Invited)

Karin M. Sandstrom

Dust plays critical roles in many of the processes occurring in the interstellar medium and dust's infrared emission serves as a tracer for the ISM and star formation from the nearby universe out to high redshift. While most of our knowledge of dust is built from observations of the local area of the Milky Way, it is clear that dust properties change dramatically in low metallicity conditions which may be prevalent at high redshift and in nearby dwarf galaxies. I will discuss what we know about how dust properties change with metallicity and how this impacts the physical state of gas in the ISM. Finally, I will describe the prospects for learning more about low metallicity dust and gas with new and upcoming observational facilities like the James Webb Space Telescope.

Constraining AGN Feedback with ISM Observations (Invited)
Luis Ho

AGN feedback is often invoked in galaxy evolution, as a key physical mechanism to self-regulate star formation and black hole accretion. Is this mechanism truly effective? How to tell? I will describe a series of experiments designed to use the ISM content of quasar host galaxies to test the efficiency of AGN feedback. I will also introduce new methods of estimating the star formation rate in AGN and quasar host galaxies.

Ionised and Atomic Neutral Gas Outflow in Local ULIRGs with MUSE: Outflows and Positive Feedback
Andrin Fluetsch

Galactic winds are invoked in simulations of galaxy evolution to shut down star formation and therefore explain several observed properties, such as the lack of over-massive galaxies or the correlation between the supermassive black hole and its host galaxy. Observational evidence of outflows has been amassed in several different phases, yet the detailed mechanism of launching these winds and the connection between different phases is poorly understood. More recently, there have also been the detections of positive feedback, where feedback by an AGN or starburst can trigger star formation both in the disc through compression by outflows as well as within the outflowing gas. We study the detailed kinematics of the ionised gas phase using Multi Unit Spectroscopic Explorer (MUSE) in a sample of 25 local (ultra)-luminous infrared galaxies ((U)LIRGs. These objects exhibit powerful outflows and mimic the behaviour at high-z where we expect outflows to play an even more important role. With this study, we aim to achieve two goals. First, we show a detailed characterisation the ionised and the atomic neutral outflow using the excellent spatial resolution of MUSE and compare them to our previous study on molecular outflow with the Atacama Large Millimetre Array (ALMA). This multi-phase approach allows us to probe different spatial scales and to obtain a more detailed and more complete picture of the mechanism driving outflows and the interplay between different phases. Second, we investigate the evidence for "positive feedback", where we directly present diagnostics showing stars being formed within the outflowing gas. To do so, we will present a detailed analysis of these 25 ULIRGs including information on outflow energetics and morphology, BPT diagrams, electron density plots as well as further evidence for positive feedback.

Gas Accretion and Outflow as Viewed from Nearby Galaxies
Lei Hao

In this talk, I will describe several projects that show gas accretion and outflows as viewed from the 2D spectroscopy for low-z galaxies.

Gas flows in the CGM: Accretion, Stellar Feedback and Cosmic Rays (Invited)
Dusan Keres

Stellar feedback and cosmological gas infall regulate the evolution of (sub) L* galaxies and their halos. Cosmological simulations with detailed models of stellar feedback on small scales within the ISM can now self-consistently generate large scale galactic outflows that lower galaxy masses, return the gas to the CGM and enrich it with heavy elements. Interestingly, if only a moderate fraction of stellar feedback is imparted to the surrounding gas in form of cosmic rays, this can significantly modify the structure and properties of the CGM and further regulate the evolution of L* galaxies. I will review recent work on the co-evolution of galaxies and the CGM in FIRE simulations, focussing on the role of cosmic rays and late time accretion onto galaxies.

Resolving Individual Stars and Multi-phase Galactic Clouds in a Cosmological Context
Thales Gutcke

I present the preliminary results from a high resolution magneto-hydrodynamical moving mesh simulation of a dwarf galaxy with 4 solar mass resolution that includes the formation of individual stars and stellar feedback from individual supernovae. This effort is a first step towards a comprehensive multi-physics ISM model that aims to be used in fully cosmological (zoom) simulations of galaxies. With this simulation, we are able to look at the small scale effects on the multi-phase ISM run with a full chemical network and see how feedback energy is transported through the gas. This model provides an ideal testing ground for different physical processes like magnetic fields, cosmic rays, and radiation transfer and the effectiveness of feedback on sub-parsec scales. This will provide a consistent galactic scale framework that resolves the cloud scales necessary to compare with high resolution observations, such as those offered by ALMA.

Numerical study of AGN feedback on a galactic scale
Feng Yuan

There are many observational evidences for the co-evolution between the supermassive black hole and its host galaxy. It is widely thought that the underlying physical mechanism is the interaction between the central active galactic nuclei and the galaxy, i.e., AGN feedback. This is a rapidly developping field and most details of how it works remain unsolved. In this talk, I will first introduce some background of AGN feedback, then I will focus on our recent series of works on AGN feedback which are based on high-resolution hydrodynamical numerical simulation. Compared to many simulation works in this field, our simulation can well resovle the Bondi radius thus can precisely calculate the accretion rate. More importantly, we adopt state-of-art AGN physics, including the proper discrimination of cold and hot accretion modes and the exact descriptions of the AGN radiation and wind in each mode. Physical processes such as star formation and SNe feedback are taken into account. I will discuss the effects of AGN feedback on the AGN light curve, growth of the black hole mass, AGN duty cycle, star formation, and X-ray surface brightness of the galaxy.

Dusty Superwind from a Galaxy with a Compact Obscured Nucleus: Optical Spectroscopic Study of NGC 4418
Youichi Ohyama

We report our optical spectroscopic study of the nucleus and its surrounding region of a nearby luminous infrared galaxy NGC 4418. This galaxy has been known to host a compact obscured nucleus, showing distinct characteristics such as a very compact (~20 pc) submillimeter and mid-infrared core and dusty circumnuclear region with massive molecular gas concentration. We detected dusty superwind outflow at ~>1 kpc scale along the disk semiminor axis in both shock-heated emission lines and enhanced interstellar Na D absorption. This superwind shows basic characteristics similar to those of the prototypical superwind in the starburst galaxy M82, such as a kiloparsec-scale extended structure of gas and dust along the disk minor axis, outflowing components (multiphase gas and dust), physical conditions of the ionized gas, and monotonically blueshifting radial velocity field with increasing distance from the nucleus on the front side of the superwind. We argue that the superwind-driving starburst is separate from the submillimeter core even if the core is a very young star cluster. Therefore, this galaxy hosts both the enshrouded compact core and the superwind-driving circumnuclear starburst.

Poster Talks, Tuesday 13:30-14:00

Star Formation Efficiency of the Galaxies at z ~ 0.15
Cheng Cheng

In this talk, I will briefly introduce our recent Valparaíso APEX/ALMA Line Emission Survey (VALES) project targeting the low-J CO emission line of 63 Herschel-detected galaxies at z~0.15. We investigate the star formation efficiencies (SFEs = SFR/M(H_2)) of galaxies at low redshift. We find the SFE of our sample bridges the gap between normal star-forming galaxies and Ultra-Luminous Infrared Galaxies (ULIRGs), which are thought to be triggered by different star formation modes. Considering the SFE as the SFR to L(CO) ratio, our data show a continuous and smooth increasement as a function of infrared luminosity (or SFR) with a scatter about 0.5 dex, instead of a steep jump with a bimodal behaviour. This result is due to the use of a sample with a much larger range of sSFR/sSFRms using LIRGs, with luminosities covering the range between normal and ULIRGs.

Properties of LBGs with [OIII] Detection at z>3: The Importance of Including Nebular Emission Data in SED Fitting
Fangting Yuan

At high redshift, the contribution of strong emission lines to the broadband photometry can cause large uncertainties when estimating galaxy physical properties. To examine this effect, we investigate a sample of 54 LBGs at 3<z<3.8 with detected

[OIII] emissions. We use CIGALE to fit simultaneously the rest-frame UV-to-NIR SEDs of these galaxies and their emission line data. Comparing the results with and without emission line data, we show that spectroscopic data are necessary to constrain the nebular model. We examine the K-band excess, which is usually used to estimate the emissions of [OIII]+Hb lines when there is no spectral data, and find that the difference between the estimation and observation can reach up to >1 dex for some galaxies, showing the importance of obtaining spectroscopic measurements of these lines. We also estimate the equivalent width of the Hb absorption and find it insignificant compared to the Hb emission.

Enhanced or Suppressed Star Formation Rates inside the Corotation Radius of Barred Spiral Galaxies
Toky H. Randriamampandry

We have measured the corotation radius (CR) of 45 barred galaxies selected from CALIFA and investigated the role of bars on the suppression or enhancement of SFR inside the CR. Galactic bar moves the gas toward the centre once the gas is located inside the CR and fuel star formation activities. Therefore, it is often assumed to be responsible for the growth of pseudo-bulges. However, the effectiveness of this process is not well understood. In this work, we use the resolved SFMS diagrams to identify spaxels that have suppressed or enhanced SFR within the CR and in the bar region. In this talk, I will discuss how we measure the CR using the phase reversal method that we applied to the gas velocity field. I will also talk about the correlation between bar properties and the suppression or enhancement of SFR within the CR.

The formation of Compact Elliptical Galaxies in the Vicinity of a Massive Galaxy: the Role of Ram-pressure Confinement
Min Du

Compact ellipticals (cEs) are outliers from the scaling relations of early-type galaxies, particularly the mass-metallicity relation which is an important outcome of feedback. The formation of such low-mass, but metal-rich and compact, objects is a long-standing puzzle. Using a pair of high-resolution N-body+gas simulations, we investigate the evolution of a gas-rich low-mass galaxy on a highly radial orbit around a massive host galaxy. As the infalling low-mass galaxy passes through the host's corona at supersonic speeds, its diffuse gas outskirts are stripped by ram pressure, as expected. However, the compactness increases rapidly because of bursty star formation in the gas tidally driven to the centre. The metal-rich gas produced by supernovae and stellar winds is confined by the ram pressure from the surrounding environment, leading to subsequent generations of stars being more metal-rich. After the gas is depleted, tidal interactions enhance the metallicity further via the stripping of weakly bound, old and metal-poor stars, while the size of the satellite is changed only modestly. The outcome is a metal-rich cE that is consistent with observations. These results argue that classical cEs are neither the stripped remnants of much more massive galaxies nor the merger remnants of normal dwarfs. We present observable predictions that can be used to test our model.

Star-disc Interaction in Galactic Nuclei: Formation of a Central Stellar Disc
Rainer Spurzem

We perform high-resolution direct N-body simulations to study the effect of an accretion disc on stellar dynamics in an active galactic nucleus (AGN). We show that the interaction of the nuclear stellar cluster (NSC) with the gaseous accretion disc (AD) leads to formation of a stellar disc in the central part of the NSC. The accretion of stars from the stellar disc on to the super-massive black hole is balanced by the capture of stars from the NSC into the stellar disc, yielding a stationary density profile. We derive the migration time through the AD to be 3 per cent of the half-mass relaxation time of the NSC. The mass and size of the stellar disc are 0.7 per cent of the mass and 5 per cent of the influence radius of the super-massive black hole. An AD lifetime shorter than the migration time would result in a less massive nuclear stellar disc. The detection of such a stellar disc could point to past activity of the hosting galactic nucleus.

Extended Lya Emission Nebulae Surrounding Tens of QSOs at Redshift 2 to 5
Yucheng Guo

Deep MUSE observations have detected extended Lya emission nebulae surrounding tens of QSOs at redshift 2 to 5. Generally these Lya nebulae are interpreted as tracers of pristine or near-pristine gas inflowing from IGM. In our work, we performed a detailed analysis on a large sample of quasars at z~3 based on MUSE data. We found clear evidence of extended emission of UV emission lines (CIV1549, HeII1640 and CIII]1909) for about 18% of the sample. The stacking of all Lya nebulae also shows clear evidence of extended UV emission lines. The average metallicity of these regions is of the order of ~0.5 solar metallicity as far as 26.4Kpc. For the filamentary part of Lya nebular, the metallicity stays stable at 0.5~1 solar metallicity as far as 41.5 Kpc. Morphologically, the UV line emission is generally more compact than Lya, both for individual objects and for stacked results. The stacked results show the CGM of these powerful quasars is composed of two components, a metal enriched one, within a few tens kpc from the quasar (whose enrichment is likely due to quasar-driven outflows), and a near-pristine one, on larger scales, likely associated with gas accreting from the intergalactic medium. These results suggest that a significant fraction of Lya nebulae are not tracing metal poor gas inflow, but CGM that has possibly been pre-enriched by quasar driven outflows, which are thought to regulate or even suppress star formation in massive galaxies.

QSO-Host Deblending Using Intergral Field Spectroscopy
David Fernandez-Arenas

Currently, observations using Integral Field Unit (IFU) represent a synergy between the properties that can be obtained using spectroscopy and their spatial distribution. In the cases of AGNs, one important problem in spectroscopy studies is the strong contamination of the host galaxy by the presence of the bright nucleus and for that reason, many studies are limited in the most cases to the outer part of the host galaxy. Therefore, alternative methods are required for the study of AGN and host galaxies using IFS. In this work, I present one method to separate the host galaxy and the AGN contribution in data-cubes. For this task, I use the spectral components of the AGN and the Point Spread Function constructed from the broad lines at different wavelength ranges. After the quasar-host deblending process, I present the case of the

Star Formation Rate and their distribution in the galaxy for the quasar PG 0934+013 derived using the Halpha emission line. The result of SFR using recombination line is consistent with the SFR derived independently from far-infrared data.

Exploring the infrared and dust properties of star-forming galaxies with different metallicities at z～0
Xu Shao

We present the metallicity distribution of a large 8 μm-selected sample at 0.02 < z < 0.3 which consists of 868 star-forming galaxies, and explore how their IR and dust properties vary with metallicity. The optical spectra observed by MMT/Hectospec are used to estimate their metallicities. We found that the dust-to-stellar mass ratio shows no significant dependence on metallicity. The mean L(IR)/L(8) increases by ~ 3 times when metallicity varies from 8.6 to 8.15, suggesting a paucity of PAH molecules in low-metallicity environment with respect to their dust content. Moreover, the SFR/L(8) has an even stronger dependence on the metallicity than L(IR)/L(8), consistent with that both the PAH and dust dependences on metallicity play important roles in determining L(8)-traced SFR. This result suggests an underestimation of SFR in metal-poor galaxies when following the conventional L(8)-to-SFR conversion found for massive galaxies. The metallicity-dependent SFR/L(8) ratio will help to unveil star formation activities more accurately in distant galaxies.

Wednesday, Sept. 11

The Physical Properties of AGN Outflows and Their Impact on Host Galaxies from Low to High redshift (Invited)
Giovanni Cresci

Quasar feedback in the form of powerful outflows is invoked as a key mechanism to quench star formation in galaxies, although direct observational evidences are still scarce, probably because radiatively driven winds are rare as they arise during a short-lived phase. I will present near-IR IFU SINFONI and ALMA observations of a prototypical high-z QSOs in the blowing phase, for which we provide observational evidence of an impact of the AGN driven outflow on the Star Formation and gas content of the host galaxies. Moreover, I will preset a detailed study carried out with MUSE 3D spectroscopy in the framework of the MAGNUM survey, to characterize in detail the properties of the outflowing gas and its impact on the hosts in a sample of nearby AGNs.

ALMA and the Nuclear Regions of Active nearby Galaxies
Christian J. Henkel

ALMA with its unprecedented sensitivity and resolution allows us for the first time to study in detail the molecular gas in nuclear environments of active extragalactic objects down to linear scales well below the size of individual giant molecular clouds. Dynamical aspects like inflow or outflow, the presence of bars as well physical parameters of the encountered clouds and deeply obscured objects with column densities in excess of 10^{26} cm^{-2} will be introduced and described.

Gas Dynamics and Angular Momentum across the Hubble Time (Invited)
Filippo Fraternali

Rotation curves of star-forming galaxies are fundamental tools to study the dynamics of these systems, their dark matter content and their angular momentum. Star-forming galaxies grow via continuous gas accretion from the surrounding environment. A key property of the accreting gas is its specific angular momentum, which plays a key role in determining the size of the final stellar disc. A relation that captures several of the properties of the accreting gas in connection with star formation and feedback is the stellar specific-angular-momentum vs mass relation. In this talk, I will present a new determination of this relation extending it to very low stellar masses, its evolution since z~1 and discuss some theoretical implications. I will then discuss the dark matter content of star-forming galaxies, in particular at high masses. A new determination of their halo masses shows that massive spirals have much higher stellar mass fractions (also called star formation efficiency) than previously thought and that the stellar-to-halo mass relation departs significantly from the currently used relations.

Energetic and Dynamical Interactions among the ISM Phases - What to Learn from High-velocity Clouds
Gerhard Hensler

It is a well-accepted scenario that galactic mass assembly happens throughout the Hubble time by cold gas infall. This process is observable in our Milky Way as well as in other gas-rich galaxies by a steady accretion of high-velocity clouds (HVCs). Since galaxies expel hot supernova gas into their halo while intergalactic gas is heated by the galaxies' gravitation to virial temperatures, HVCs have to pass through this hot halo gas. Because their state resembles the regular multi-phase character of the interstellar medium (ISM), from the energetic and dynamical interactions of cool HVCs with the hot gas one can learn about the interplay of the ISM phases. In particular, understanding the reason of lacking star formation (SF) in HVCs under this extreme dynamical state should provide insight into the conditions for SF itself. By 3D numerical models we explore the evolution of HVCs, demonstrate the importance of self-gravity, study the conditions for possible ram-pressure compression to reach Jeans mass, the role of thermal conduction, and how magnetic fields affect heat conduction. The HVC models are compared with observations and with gas clouds which are stripped off from galaxies by ram pressure in galaxy clusters due to the similarity of conditions.

The Physical Condition of the ISM Over Cosmic Time: Lessons for Galaxy Evolution
Xiangcheng Ma
Understanding how the physical conditions of the ISM, star formation activity, and the strengths of stellar feedback evolve over cosmic time is crucial for establishing a coherent picture of galaxy evolution. Using a sample of realistic, high-resolution cosmological zoom-in simulations, I will show at sufficiently high redshift ($z>1$), the ISM is mainly supported by turbulent motion driven by rapid gas infall, mergers, and feedback. Feedback drives violent galaxy-scale outflows and star formation is highly

bursty. Rotationally supported disks may form transiently in relatively massive galaxies but they can be disrupted quickly by feedback. Milky Way-like galaxies form a stable gas disk below z~1 (disk settling), since when star formation become smooth (Ma et al. 2017a). Such evolution of ISM properties have important implications in galaxy evolution. I will show this picture naturally explains why local galaxies commonly have negative gas-phase metallicity gradients, while high-redshift (z>1) galaxies show a variety of metallicity gradients. This is because metal mixing is efficient in high-redshift galaxies due to turbulence and feedback. Negative gradients are usually associated with rotationally support disks, but disks are more vulnerable and less common at higher redshifts (Ma et al. 2017b). Moreover, I will also show that in high-redshift galaxies, progenitors of present-day globular clusters form efficiently in high-pressure clouds compressed by feedback-driven outflows and cloud-cloud collision, which such clusters are more difficult to form at lower redshifts (Ma et al. 2019b). I will discuss how to test this picture with current and future observations.

Thursday, Sept. 12

Disk Structure, Turbulence, and Dark Matter in Star-forming Galaxies at z~0.7-3.8 (Invited)
Sedona Price

Recent large near-infrared spectroscopic studies now enable systematic studies of the evolution of galaxy dynamics and structures from the peak of cosmic star formation through today. These studies include the SINS/zC-SINF, KMOS-3D, and MOSDEF surveys, which together provide observations of ionized gas kinematics for ~1500 star-forming galaxies from z~0.7-3.8. These samples show that the majority of massive star-forming galaxies have disk structures by at least z~2, but are more baryon-rich in early epochs than now. Additionally, we find that velocity dispersions increase towards higher redshifts, following the evolution of galactic gas fractions. Comparing these findings to theoretical work, we examine what processes and properties impact disk turbulence and how this changes over time, and discuss remaining tensions between observed and predicted mass distributions in early galaxies.

A Multi-Phase Gas Description and its Implications for Numerical Models of Dwarf Galaxies
Matthias Kühtreiber

We present results from our N-body/SPH code “cd-sph” including a multi-phase description of the interstellar medium (ISM). This approach aims at overcoming various issues of a single gas phase used in most hydrodynamical simulations. The ISM is modelled more realistically by adding a cold cloudy medium to the hot/warm gas represented by SPH particles. These clouds are treated with the sticky-particle method and allow for coagulation and fragmentation of molecular clouds. The formation of stars is realized by directly applying the Jeans criterion to the clouds. Stars, which are treated as collisionless N-body particles, and the gas phases are mutually coupled by mass, momentum, and energy exchange in a self-consistent manner. Different feedback processes from stars are taken into account distributing energy, mass and newly produced chemical elements to the cold clouds or to the hot/warm medium. Depending on the stellar mass, UV radiation, stellar winds supernovae type II, type Ia and planetary nebulae, are considered. The different gas phases are not decoupled from each other, as they can exchange mass, including chemical elements and energy through thermal conduction, leading to condensation or evaporation. Due to their different dynamical properties, additional drag forces are included which lead to momentum exchange between clouds and the gaseous medium.We apply our model to isolated dwarf galaxies in order to investigate their chemo-dynamical evolution and make comparisons with observations and with single-phase simulations. Thereby, we demonstrate the differences of the dynamics and chemical evolution due to the multi phase ISM and the stellar feedback processes which affect the clouds and the hot/warm medium in a decoupled manner. We further discuss mass loading as an important process for the chemo-dynamical evolution in dwarf galaxies and implications for simulations of ram pressure stripping.

From High Redshift Sub-millimeter Galaxies to Early-types in the Local Universe
Francesca Rizzo

The bulk of stellar masses in elliptical galaxies and in the bulges of local spiral galaxies formed at redshift $z > 2$. A number of studies have revealed that there is an evolutionary connection between the sub-millimeter galaxies (SMG) at $z > 2$ and the quiescent galaxies observed at lower redshift. However, a direct probe of the structural and morphological properties of high redshift SMGs is mainly hindered by the low spatial resolutions, low signal-to-noise ratios and dust obscuration. In this talk, I would like to show the first direct evidence of a bulge in a SMG at $z \sim 4$, through a kinematic studies of [CII] line. The spatial resolution of ～ 100 pc, that is achievable by combining ALMA and gravitational lensing, allows me to sample the rotation curve in the inner regions, where the signature of a bulge was identified. Finally, the kinematic study of a small sample of $z \sim 4$ SMGs allows me to provide new insights on the formation models of quiescent galaxies at $z < 2$.

On the Determination of Rotation Velocity and Dynamical Mass of Galaxies Based on Global HI Profile
Niankun Yu

The dynamical mass of a galaxy (Mdyn) probes its total baryonic and dark matter content and is of great im-portance for many aspects of galaxy evolution. We investigate an efficient method to estimate galaxy dynamical mass using line widths measured from unresolved, integrated HI spectra of galaxies, such as those currently available from the ALFALFA survey and future blind surveys using FAST and ASKAP. As Mdyn ～ R $(V/\sin i)^2$, a major challenge is to measure projected velocity (V), while we still need a size scale (R) and inclination angle (i) relevant for the HI disk of the galaxy. We develop a new method to measure line width and total integrated flux of HI global profiles based on the Curve of Growth for single-dish emission line spectra. Then we simulate various HI profiles using Busy Function and test the robustness of results especially for low signal-to-noise ratio (SNR) spectra. Using local galaxies with available resolved HI maps and rotation curves, we quantify the most accurate corrections applied to line widths derived from integrated HI spectra. Combined with a recently determined tight relation between HI mass and HI diameter, we present a new empirical relation to estimate galaxy dynamical mass.

The Startling Dynamics of HI-rich Ultra Diffuse Galaxies
Pavel E. Mancera Piña

We study the gas kinematics traced by 21-cm emission of a sample of six ultra-diffuse galaxies (UDGs) rich in neutral hydrogen (HI). Using the 3D modelling code 3D-Barolo we derive robust rotation velocities, revealing a startling feature: HI-rich UDGs are clear outliers from the Baryonic Tully-Fisher Relation (BTFR), with circular velocities much lower than galaxies with similar baryonic mass and higher surface brightness. This suggests that the distribution of late-type systems in the velocity–baryonic mass plane is broader than previously observed. We find that we cannot plausibly reconcile these objects with the BTFR by invoking errors in the mass, inclination, distance, or correction for the non-rotational component of the kinematics. Notably, the baryon fraction of our UDG sample is consistent with the cosmic mean: these UDGs are compatible with having no "missing baryons". Moreover, the gravitational potential provided by the baryons is sufficient to account for the amplitude of the rotation curve, unlike other galaxies with similar circular velocities whose dynamics are typically dark matter-dominated. We speculate that any formation scenario for these objects will require very inefficient feedback and a broader diversity in the inner dark matter content, implying a new, stringent constraint on models of galaxy formation.

The Low-Redshift Circumgalactic Medium with Sub-Kpc Resolution (Invited)
Freeke van de Voort

Galaxies are intimately connected to the environments they live in: they grow by accreting gas from the circumgalactic medium (CGM) and they heat and enrich the CGM through galactic outflows. Most cosmological, hydrodynamical simulations focus their computational effort on the galaxies themselves and treat the CGM more coarsely, which means small-scale structure cannot be resolved. I will discuss how we get around this issue by running zoom-in simulations of a Milky Way-mass galaxy with standard mass refinement and additional uniform spatial refinement within the virial radius. The improved spatial resolution does not strongly impact the average density of the CGM. However, it samples strong overdensities and underdensities much better and therefore drastically changes certain observables, such as the amount of atomic hydrogen or hydrogen H-alpha emission. It may even lead to enhanced star formation in the central galaxy. Therefore, I will conclude that some of the properties of the CGM are strongly resolution dependent, while others are more robust. This is especially important when using simulations to predict or interpret observations of the CGM or of the intergalactic medium.

Galaxy Outflows in the Circumgalactic Medium at Cosmic Noon (Invited)
Nikole Nielsen

The star formation history of the universe reveals that galaxies most actively build their stellar mass at cosmic noon, roughly 10 billion years ago, with a decrease toward present-day. The resulting metal-enriched material ejected from these galaxies due to supernovae and stellar feedback is deposited into the circumgalactic medium (CGM), which is a massive reservoir of diffuse, multiphase gas out to radii of 200 kpc. The CGM is the interface between the intergalactic medium and the galaxy, through which accreting filaments of near-pristine gas must pass to contribute new star formation material to the galaxy, and outflowing gas is later recycled. Simulating these baryon cycle flows is crucial for accurately modeling galaxy evolution. We examine these multiphase CGM gas flows with the quasar absorption line technique, primarily focusing on the low-ionization MgII absorption doublet (log (T) = 4 K), with additional multiphase ions such as Lyman alpha, SiII, and CIV. With the combination of HST images, high-resolution UVES/VLT quasar spectra, and cutting-edge IFU data from the Keck Cosmic Web Imager, we quantify the gas kinematics and metallicities of outflowing gas at 70 kpc along the minor axis of an edge-on (i=85deg) galaxy at cosmic noon (zgal=2.070). Connecting these results to our Multiphase Galaxy Halos Survey at z~0.3, we study the evolution of CGM kinematics and metallicities over nearly 10 billion years.

Direct Detection of the Circumgalactic Medium Using Dragonfly
Deborah Lokhorst

We describe a new approach to studying the intergalactic and circumgalactic medium in the local Universe: direct imaging. We have modified the Dragonfly Telephoto Array to turn it into an ultra-sensitive line emission mapper. This upgrade is designed to target the extremely low surface brightness visible-wavelength line emission from gas in the cosmic web, which feeds into galaxies and fuels star formation. Using hydrodynamical cosmological simulations (EAGLE) we investigate the expected brightness of this emission at low redshift (z < 0.2) and find that H-alpha emission in extended halos of galaxies (analogous to the extended Lyα halos/blobs detected around galaxies at high redshifts) and the fluorescent ‘skin' of local ‘dark' HI clouds could be directly imaged in exposure times of ~10 hours. We will present first results from our prototype and speculate on the ultimate limits of an upgraded array.

Understanding the Cool Circumgalactic Medium of Passive Galaxies
Andrea Afruni

The circumgalactic medium (CGM) of galaxies consists of a multiphase gas with components at very different temperatures, from 10^ 4 K to 10^ 7 K. Characterizing this medium is crucial to understand galaxy evolution, however its origin, dynamics and fate are to date unclear and debated. One of the greatest puzzles about the CGM is the presence of a large amount of low-temperature (T~10^4 K) gas in the halos of quiescent early-type galaxies (ETGs). Using semi-analytical parametric models, we describe the properties of the cool CGM around massive, low-redshift ETGs as the cosmological accretion of intergalactic gas into their dark matter halos, resulting in an inflow of clouds from the external parts of the halos to the central galaxies. We compare our predictions with the recent observations of the COS-LRG collaboration. We find that inflow models can successfully reproduce the observed kinematics, the number of absorbers and the column densities of the cool gas. Our MCMC fit returns masses of the cool clouds of about 10^5 solar masses and shows that they must evaporate during their journey due to hydrodynamic interactions with the hot gas. We conclude that most of the cool gas present in the halos of quiescent ETGs cannot reach the central regions and feed the galaxy star formation, thus going in the direction of explaining why these passive objects are no longer forming stars.

The REQUIEMSurvey: A Statistical Study of Quasars' Circum-Galactic Medium at the Cosmic Dawn
Emanuele Paolo Farina

QSOs at z>6 are among the most luminous sources in the Universe. Their luminosity is produced by extreme gas accretion onto their central black holes, which grow by 20x in only 100Myr. Simultaneously, QSO host galaxies form hundreds of stars per year, using up gas in the process. To understand the sustained and rapid gas consumption of these extreme sources, we started a VLT/MUSE program aimed to directly detect the diffuse ionized gas in the immediate environment of a statistical sample of z>6 QSOs dubbed: the Reionization Epoch QUasars InvEstigation with MUSE (REQUIEM) survey. Providing the first coherent study of extended bright Ly-Alpha nebulae in the environment of z>6 QSOs, the REQUIEM survey delivers the first direct map of the circum--galactic medium of the most massive galaxies at the dawn of the Universe and provides a unique opportunity to connect the intergalactic medium with the QSO host galaxies and their central black holes.

Evolution of the Circumgalactic Medium in Massive Halos from z= 3 to z=2
Zheng Cai

Motivated by the recent discovery of the near-ubiquity of Lyα emission around z 3 QSOs, we performed a systematic study of QSO circumgalactic Ly-alpha emission at z ≈ 2, utilizing the unique capability of the Keck Cosmic Web Imager (KCWI) – a new wide-field, blue sensitive integral-field spectrograph (IFU). In this talk, we present KCWI observations on a sample of 16 ultraluminous Type-I QSOs at z = 2.1 − 2.3. We found that each observed QSO is associated with a Lyα nebula with projected linear-size larger than 50 physical kpc (pkpc). Among them, two nebulae have an extremely high Lyα luminosity of LLya > 1044 erg s−1 extending beyond the field of view of KCWI. Our KCWI observations reveal that most z ≈ 2 QSO nebulae have a more irregular morphology compared to those at z=3. Moreover, using our current sample we measure that the circularly-averaged surface brightness (SB) at z = 2 is 0.4 dex fainter than the redshift-corrected, average SB at z=3. Our observations suggest that the luminosity of the diffuse Lya emitting regions at z = 2 is consistent with that at z = 3, but the the observed lower redshift-corrected, circularly-averaged SB could be due to the lower covering factor of cool gas clouds at from z = 3~ z = 2.

Evidence of Infalling Gas in A Lyman Alpha Blob
Yiping Ao

Lyman alpha blobs (LABs) are spatially extended nebulae of emission in the Lyman alpha line of hydrogen, seen at high redshifts, and most commonly found in the dense environment of star-forming galaxies. The origin of Lyman alpha emission in the LABs is still unclear and under debate. Proposed powering sources generally fall into two categories: (1) photoionization, galactic super-winds/outflows, resonant scattering of Lyman alpha photons from starbursts or active galactic nuclei (AGNs) and (2) cooling radiation from cold streams of gas accreting onto galaxies. Here we analyze the gas kinematics within a LAB providing rare observational evidence for infalling gas. This is consistent with the release of gravitational accretion energy as cold streams radiate Lyman alpha photons. It also provides direct evidence for possible cold streams feeding the central galaxies. The infalling gas is not important by mass but hints at more than one mechanism to explain the origin of the extended Lyman alpha emission around young galaxies. It is also possible that the infalling gas may represent material falling back to the galaxy from where it originated, forming a galactic fountain.

Can Observations of Turbulence Serve as a Probe of Gas Accretion onto Galaxies?
Itzhak Goldman

According to simulations of large scale structure formation within the LCDM cosmology, there should be gas accretion onto galaxies from the halo inside which they formed. As of now there is no convincing direct observational evidence for this process. The accreted gas is thought to be ionized, at least partially, multi-phase, possibly clumped, quiet homogeneously distributed and hence tenuous. All the above make direct observation difficult. Recently there were reports on observations of a galaxy with enhanced star formation in regions of low. This is interpreted as primordial gas being accreted onto the galaxy. Here we suggest an additional indirect probe: the observation of a large scale (exceeding few kpc) turbulence caused by the accretion. As a specific example for an instability that generates turbulence we consider the Helmholtz Kelvin instability. We employ a semi-analytic model of turbulence and derive the turbulence power spectrum. The latter has a unique shape that distinguishes it from ordinary ISM turbulence.

Poster Talks, Thursday 13:30-14:00

Ionized Gas Kinematics in Galaxy Pairs
Shuai Feng

In this work, we study the kinematic field of ionized gas in galaxy pairs based on MaNGA data. Through the package KINEMETRY, we decompose the velocity field of Ha into the circular component and non-circular component. We find that the strength of non-circular component increases as decreasing projected distance. The paired galaxies with strong non-circular components show a significant enhancement of both total SFR and central SFR, and dilute central gas phase metallicity. While the others, paired galaxies with weak non-circular components, is similar to the field galaxies. These phenomenons maybe indicate that the non-circular component of ionized gas contains the clues of gas inflow during galaxy-galaxy interaction.

Evidence Regarding the Role of Gas Accretion in Growth of Discs in Galaxies
Sonali Sachdeva

An in-depth analysis of morphological and stellar parameters of galaxies at intermediate ($0.4<z<1.0$) and high redshifts ($1.5<z<4.0$) suggests that gas accretion has played a crucial role in the formation and growth of discs in galaxies. This evidence has been obtained by performing careful bulge-disc decomposition of hundreds of galaxies (individually) in Chandra Deep Field South using HST images in the optical and near infrared wavebands. Examining the evolution in the fraction of 2-component/1-component galaxies, along with their luminosity, size, B/T, stellar mass and star formation activity, we find that continuous accretion from the IGM appears to have played a more dominant role than other evolutionary mechanisms (i.e., mergers, secular evolution) in disc growth. Performing bulge-disc decomposition of the Ks band morphologies (which are closest to the stellar mass distribution) of 1263 local galaxies in Stripe-82 and studying their correlation with stellar parameters (including velocity dispersion), we find more substantial clues regarding the role of gas accretion.

Strong MgII and FeII absorbers from 2< z <6
Siwei Zou

We present the results of a survey for intervening MgII and FeII absorbers in redshift range 2< z < 6 with a quasar sample at z > 5.7, obtained with the Gemini NIR camera. Gas in the circumgalactic medium (CGM) hold clues to understanding the exchange of baryons between galaxies and their surroundings. It is the poorly understood flows of gas into galaxies, and from them back into their environments especially at high redshift. The MgII absorbers in our sample are with Wr > 0.8 Å, we present the population and equivalent width distribution of MgII and FeII absorbers. The population of strong absorbers and MgII / FeII ratio suggest a connection to the star formation rate density, as they trace galactic outflows or other byproducts of star formation.

Big Data Quasar Spectroscopy: Multiphase Probes of the Baryon Cycle
Alejandra Fresco

According to the Standard Cosmological Model, the universe is made up of 5% ordinary matter, 25% dark matter, and 75% dark energy. The stars and gas in galaxies, the cold and hot gas in galaxies, hot intracluster medium and cool intergalactic gas make up almost half of the baryons expected in the universe. Galactic growth is regulated by accreting mass and momentum via intergalactic medium, and lose them via strong outflows driven by AGN or supernovae. Since the IGM is very difficult to observe due to its weak emission, quasars are used as a background source to detect this gas in absorption. This study’s primary goal will be to probe the hot phase of the gas using high ionization UV lines from public data releases in the optical wavelength such as KODIAQ (O’ Meara et al. 2015) and SQUAD (M. T. Murphy et al. 2018) surveys.

Rapid Gas Accumulation in Tidal Arms and the Formation of Dwarf Galaxies
Gerhard Hensler

We present, for the first time, chemo-dynamical numerical simulations of formation and growth of young tidal dwarf galaxies (TDGs), including a self-consistent treatment of the tidal arm in which they are embedded. Thereby, we do not rely on idealized initial conditions, as the initial data of the presented simulation emerge from a galaxy interaction simulation. By comparing models which are either embedded in or isolated from the tidal arm, we demonstrate the importance of the tidal arm on the evolution of TDGs, as additional source of gas which can be accreted and is available for subsequent conversion into stars. During the initial collapse of the proto-TDG, with a duration of a few 100 Myr, the evolution of the embedded and isolated TDGs is indistinguishable. Significant differences appear after the collapse has halted and the further evolution is dominated by the possible accretion of material from the surroundings tidal arm. The inclusion of the tidal arm in the simulation of TDGs results in roughly a doubling of the gas mass and fraction, an increase in stellar mass by a factor of 1.5, and an approximately three times higher star-formation rate compared to the isolated case.

Moreover, we perform a parametric study on the influence of different environmental effects, i.e. the tidal field and ram pressure. Due to the orbit of the chosen initial conditions, no clear impact of the environmental effects on the evolution of TDG candidates can be found.

Although TDGs' low gravitation can merely acquire Cold Dark Matter (CDM) from the massive galaxies from phase-space arguments and, therefore, not be gravitationally supported by DM halos, even at high SFRs, surprisingly none of the models is disrupted by extreme stellar feedback. Their survival, therefore, questions their contribution to the DG population in the cosmos

Morphological Galaxy Transformation of Dwarf Galaxies at Cluster Infall
Gerhard Hensler

Ram-pressure stripping (RPS) is a well observed phenomenon of massive spiral galaxies passing through the hot intra-cluster medium (ICM) of galaxy clusters. For dwarf galaxies (DGs) within a cluster the transformation from gaseous to gas-poor systems by RPS is not easily observed and must have happened in the cluster outskirts already.

A few objects are indeed observed in the RPS act in closeby galaxy clusters, and the field. Since cluster early-type DGs also show a large variety of internal structures (unexpected central gas reservoirs, blue stellar cores, composite radial stellar profiles), the aims of the present study are at investigating, how the ram pressure (RP) affects the interstellar gas content and therefore the star-formation (SF) activity. By a series of numerical simulations the dependency of the stripped-off gas on the velocity of the infalling DGs and on the ambient ICM density is quantified. It is demonstrated that SF can experience either suppression or trigger by RP, depending on the ICM density and the DGs mass. Under some conditions, RP can compress the gas, so that it is unexpectedly retained in the central DG region and forms stars. When gas clouds are still bound against stripping but lifted from a thin disk and fall back, their new stars form an ellipsoidal (young) stellar population already with a larger velocity dispersion without the necessity of harassment. Most spectacularly, star clusters can form downstream in stripped-off massive gas clouds in the case of strong RP. These results are compared to observations.

How HI Populates Haloes : Simulations vs. Observations
Garima Chauhan

All HI surveys are affected by selection effects, which in some cases can be quite complex. To understand these biases and how they affect our understanding of how galaxies populate dark matter halos, we have modeled HI emission lines of the galaxies in the semi-analytic model of galaxy formation Shark, built on the LCDM SURFS suite of N-body simulations. We use the latter to create a mock ALFALFA survey with the same selection function and instrumental effects as the real survey. We explored the long-standing problem of the over-production of low circular velocity galaxies, and found our simulated ALFALFA survey to reproduce the observed HI velocity width distribution very well; hence, concluding that the discrepancies previously reported are due to the complex selection effects of HI surveys. We also found that these biases affect galaxies even at the dwarf galaxy regime. During this talk, I will present these results, and also show which biases might affect the upcoming HI surveys like WALLABY and DINGO, and how best to tackle them.

Unraveling Gas-galaxy Connection: Gas Flows in Circum and Inter-galactic Environment
Ravi Joshi

Study of gas flows in and around galaxies holds the key to understand the galaxy formation and evolution. However, the low-density nature of gas poses a major challenge to detect the gas in emission and limits our understanding of how galaxies acquire the fresh fuel needed for the formation of new stars. One of the powerful tools to study the CGM is offered by absorption lines observed in background quasar spectra which trace the neutral gas reservoir for star formation. I will discuss our recent efforts to understand the nature of cool gas traced by MgII absorbers based on direct detections as well as stacked spectra, the associated star formation rate and its dependence on absorber's properties such as equivalent with, redshift and other metal lines (e.g., FeII). I will also present our efforts to link the neutral hydrogen (HI) gas to star-formation within and around galaxies at high-redshift, $z>2$ based on stacks and IFU survey.

Friday, Sept. 13

The Magellanic System: the Puzzle of the Leading Gas Stream
Thor Tepper Garcia

The Magellanic Clouds (MCs) are the most massive gas-bearing systems falling into the Galaxy at the present epoch.They show clear signs of interaction, manifested in particular by the Magellanic Stream, a spectacular gaseous wake that trails from the MCs extending more than 150 deg across the sky. Ahead of the MCs is the "Leading Arm" usually interpreted as the tidal counterpart of the Magellanic Stream. The MCs and their associated gas structures, collectively referred to as 'The Magellanic System', constitute the ultimate benchmark to test our theories on how the Galaxy accretes gas and how this gas may ultimately feed into the sites of star formation. In this talk, I will revisit the formation the MSys in a first-infall scenario in the light of a new hydrodynamic model, and will discuss its implications for our understanding of the gas circulation processes around the Galaxy.

A Hydrostatic Model for The Hot Circumgalactic Medium of the Milky Way
Fulai Guo

The circumgalactic medium and feedback processes in the Milky Way and normal disk galaxies are an interesting and important topic in contemporary astronomy. I will talk about our recent work on a new hydrostatic model for the hot halo gas in the Milky Way, the potential importance of cooling flows and AGN feedback, particularly the Fermi bubble event, in the Milky Way.

ISM and Star Formation across the Milky Way (Invited)
Cara Battersby

I will provide an overview of the hierarchical structure of molecular clouds in our ISM, from the scales of clouds to cores. I will also summarize some statistical studies of high-mass and clustered star formation from large Galactic Plane surveys. Finally, I will discuss the role of environment in star formation, using our Galactic Center as an example of star formation in an extreme environment.

A Radio/Submm View of Massive, Deeply Embedded Clusters in Our Galaxy (Invited)
Roberto Galvan-Madrid

I will present recent results on the following important issues on star-cluster formation:
i) A diversity of massive, cluster forming clouds in the Milky Way and nearby galaxies.
ii) The first censuses of their massive (proto) stellar populations, and the effects of their feedback.
iii) Searches for intra-cloud star formation relations.

Measuring the Total Gas Mass in the Galaxy
Di Li

Our knowledge of the gaseous universe was largely built upon observation of the HI 21cm hyperfine transition and the millimeter CO rotational lines. The intrinsic caveat is the lack of direct probe of cold, molecular hydrogen, due to its lack of a permanent dipole, despite the fact that all the stars were borne in it. The commonly used X-factor, which supposed to provide an estimate of total molecular gas through X*W(CO), lacks a solid physical foundation. The observation of diffuse gamma-ray emission by EGRET and Fermi (e.g. Grenier et al. 2005 Science) and Planck (2011) have independently suggest previous undetected H2, a.k.a. dark molecular gas (DMG), previous missed by CO mapping. We have tackled DMG through a plethora of techniques. Utilizing teraHertz C+ fine structure line along with HI narrow self-absorption (HINSA), we measured the excitation temperature of Galactic DMG to be about 50K (Tang, Li et al. 2016, 17). Through quasar absorption in cm band, we found abundance hydrides, OH in particular, the abundance of which traces DMG well (Li et al. 2018). Using ALMA, we found HCO+ in absorption, where there is no CO emission (Luo, Li et al. 2019). In summary, the molecular gas mass in the Galaxy was substantially underestimated by at least a factor of a few. The X-factor applying to other galaxies should be revised up by similar amount. More systematic observation of simple hydrides have the potential to characterize the DMG well enough to actually constrain star formation efficiency.

Magnetised Clouds in the Galactic Corona: Fuel for Future Star Formation?
Asger Groennow

The Galactic halo contains a complex ecosystem of multiphase intermediate-velocity and high-velocity gas clouds whose origin has defied clear explanation. They are generally believed to be involved in a Galaxy-wide recycling process, either through an accretion flow or a large-scale fountain flow, or both. Recent numerical studies have found that they accrete gas efficiently from the hot corona as they move through it. In these models, gas stripped from the clouds mixes with the low density coronal gas significantly reducing its cooling time scale. The newly cooled gas follows the cloud to the disk where it is accreted and may fuel star formation. These studies, however, ignore the effects of the coronal magnetic field and are typically two-dimensional. In this talk, I will present our 3D high-resolution simulations where we find that the magnetic field significantly decreases the amount of mixing by damping instability along the cloud boundaries. This in turn suppresses the condensation in the wake of clouds substantially lowering the efficiency of fountain-driven accretion. These accretion rates are in better agreement with observational constraints compared to the excessive accretion seen in our non-magnetic simulations.

Opportunities and Challenges of Dust Studies in the Era of Precision Galactic Astronomy
Haibo Yuan

With large scale surveys such as Gaia and LAMOST, we are entering an era of precision Galactic astronomy, whereas basic astrometric, photometric, and spectroscopic stellar parameters are measured to extreme high precision. Using the "star pair" technique, we have measured multi-band reddening values of about 5 million stars at a 1 per cent accuracy, providing a great opportunity to trace the distrbutions and properties of dust in the Galaxy. In this contribution, we will focus on three topics: 1) the 3D large scale distribution of dust in the Galaxy, i.e., the first discovery of (thin and thick) dust disks and dusty halo in the Galaxy and discussions of their properties and origins; 2) possible detection of dust reddening effects caused by zodiacol dust within the solar system; 3) the needs and challenges of high precision dereddening of Galactic and extra-galactic targets.

The TOP-SCOPE Survey of Planck Galactic Cold Clumps
Tie Liu

Stars form in dense regions within molecular clouds, called pre-stellar cores (PSCs), which provide information on the initial conditions in the process of star formation. The low dust temperature (<14 K) of Planck Galactic Cold Clumps (PGCCs) makes them likely to be pre-stellar objects or at the very initial stage of protostellar collapse. "TOP-SCOPE" are joint survey programs targeting at Planck Cold Clumps. "TOP", standing for "TRAO Observations of Planck cold clumps", aims at an unbiased CO/13CO survey of 2000 Planck Galactic Cold Clumps with the Taeduk Radio Astronomy Observatory 14-meter telescope. "SCOPE", standing for "SCUBA-2 Continuum Observations of Pre-protostellar Evolution", is a legacy survey using SCUBA-2 onboard of the James Clerk Maxwell Telescope (JCMT) at East Asia Observatory (EAO) to survey 1000 Planck galactic cold clumps at 850 micron. We are also actively developing follow-up observations with other ground-based telescopes (NRO 45-m, Effelsberg 100-m, IRAM 30-m. SMT, KVN, SMA, ALMA). We aim to statistically study the initial conditions of star formation and cloud evolution in various kinds of environments. I will present the progress and the future plans of this internationally collaborating project. In particular, I will show the preliminary results of our ALMA follow-up observations of 72 "SCOPE" cold cores in the Orion complex.

Ionized Gas and Magnetic Fields Observed in the Milky Way
JinLin Han

I will show some observational results on the ionized gas for polarization and depolarization. Some regions have obvious effect on Faraday rotation measures. It is intriguing to see how the magnetic fields in AU-scale clumps around star formation regions are linked with the global structure of magnetic fields in the Galactic disk.

The Largest Filaments in the Milky Way and Implication on Star Formation
Ke Wang

The largest filamentary structure in our Galaxy can reach up to 100 pc and beyond. In the past years, several teams have identified large-scale (>10 pc) filaments in the Galactic plane using different methods. It has been found that 1% of the ISM mass is confined in the large-scale filaments; 1/3 of these filaments are running along the center of spiral arms, marking 'bones' of the Milky Way. The filaments introduce inhomogeneity in the ISM which help mass concentration; clumps in filaments are observed to be ~5 times denser than elsewhere. In this talk, I will review the community effort to identify and characterize large-scale filaments, and discuss how these features may affect Galactic star formation.

Poster Talks, Friday 13:30-14:00

Modelling the HI Gas and Ionized Gas in Galaxy Clusters and Groups
Jian Fu

We show our work on the HI gas and hot gas based on the new L-Galaxies2019 semi-analytic models of galaxy formation. The new model can give radial resolved distribution of gas, star, metallictiy on each galaxy disk. Based on the model outputs, we can simulate the 21cm observations for HI gas. The mock catalogues can give the 21cm flux, velocity profiles and distribution of velocity width for galaxy clusters and groups. With the benefit of the ELUCID simulation haloes, we can also offer the coordinates for each model galaxy, which can be consistent with the density filed of our real universe. On the other hand, we also make the models on the distribution of ionized gas in CGM/ICM. Our model can give the radial distribution of hot gaseous halo in galaxy clusters and reproduce the scaling relation Lx-Tx and Lx-M200 from the X-ray observations, which can help to mock the X-ray observations for future surveys.

Detection of the Circumgalactic Medium of Nearby Galaxies via Emission Lines
Huanian Zhang

Galaxies are surrounded by diffuse and extended gas, which is often called the circumgalactic medium (CGM) and is the least understood part of galactic ecosystems. The CGM harbors more than 60% of the total baryons in a galaxy, is both the reservoir of gas for subsequent star formation and the depository of chemically processed gas, energy, and angular momentum from feedback. Observations and simulations of the CGM suggest that it is a multi-phase medium characterized by rich dynamics and complex ionization states. The study of the CGM has so far generally come from absorption line studies of the spectra of distant objects, typically QSOs, whose lines of sight intersect lower redshift galaxy halos. However, such study is limited by statistics. Instead, I will describe a novel approach to study the CGM via emission lines, which allows for direct mapping of individual galaxies and a variety of results obtained.

Molecular Gas Properties in the Early Merger System Arp 240
Hao He

I present results of an ALMA study that explores the physical properties of the molecular gas in the early merger system Arp 240. I use spectral line data of 12CO 1-0, 13CO 1-0 and 12CO 2-1 for both spiral galaxies in the system, NGC 5257 and NGC 5258. Both galaxies show gas concentration in some certain regions, while NGC 5258 has gas concentration in the south spiral arm instead of the center. I explored the kinematic properties of the molecular clouds based on measured 12CO 2-1 intensities and velocity dispersions from individual pixels. The results show both galaxies have relatively constant scale height of the gas disk, but have pressure spanning in a large range. Pressure is known to have a large influence on the star formation efficiency (SFE) of clouds. I calculated the SFE based on the VLA 33 GHz continuum data. The SFE varies a lot in different regions, which could be regulated by the turbulent pressure. I further studied the molecular gas properties based on a RADEX multiline analysis. The input line ratio of 12CO/13CO 1-0 shows a downward trend from the outer region to the inner region, which may suggest that gas with a high [12CO]/[13CO] abundance ratio is flowing inwards from the outer region. Based on the modeling results, I calculated the conversion factor of gas concentrated regions, which is 2.64 and 3.14 (unit: M⊙ (K km s−1 pc2)−1) for NGC 5257 and NGC 5258 respectively. These values are clearly lower than the conversion factor of Milky Way but higher than the typical ULIRG value, which corresponds to the simulation results of conversion factors in early merger systems.

Kinetic Temperature in OMC-1
Xindi Tang

We mapped the kinetic temperature structure of the OMC-1 with H_2CO (303-202, 322-221, and 321-220) using the APEX 12m telescope. Using the RADEX non-LTE model, we derive the gas kinetic temperature modeling the measured averaged line ratios of H_2CO 322-221/303-202 and 321-220/303-202. The gas kinetic temperatures derived from the H_2CO line ratios are warm, ranging from 30 to >200 K. The non-thermal velocity dispersions of H_2CO are positively correlated with the gas kinetic temperatures in regions of strong non-thermal motion of the OMC-1, implying that the higher temperature traced by H2CO is related to turbulence on a ~0.06 pc scale. We find direct evidence for the dense gas along the northern part of the OMC-1 10 km s^{-1} filament heated by radiation from the central Orion nebula.

Chemical Evolution of Massive Star Formation Regions
Jianjun Zhou

Many authors studied the chemical evolution of massive star forming regions using molecular spectral lines such as N_2H+(1-0), HCN(1-0), HNC(1-0) and CN(1-0). However, these studies did not always give the consistent results. Our results suggest that abundances of these molecules display an obvious trend of decrease with increasing H2 column density. This may be attributed to that these molecular lines are not very optically thin, while dust emission are optically thin. So it is difficult to trace the chemical evolution of massive star forming regions with these molecular lines.

A Study of Interstellar Carbon Chain Molecules
Yufang Wu

Carbon-chain molecules (CCMs) are important components of interstellar matter. They are abundant in cold, dark starless cores where they forming via early carbon-chain chemistry (ECCC). The most typical source is TMC-1 and Taurus was found as CCM-rich core gathering region in our Galaxy. In star formation regions N-bearing CCMs are still abundant but S-bearing ones are not or marginal detected. Although two protostellar cores L1527 and Lupus I-1 (IRAS 15398-3359) were found with abundance CCMs and identified as warm carbon-chain chemistry (WCCC) sources, the emission of S-bearing species are still weak. The question is when star formation is more active, are the N-bearing species still abundant there? Will the S-bearing species be quenched?

Recently we observed three protostellar cores with more developed star forming activities using Tian Mar radio telescope of Shanghai Observatory. We found that in two regions (IRAS20582+7724, L1221) and one known CCM produced region L1251A with outflows and jets, N-bearing CCMs are no longer abundant while emissions of S-bearing were not reduced but increased. The C_3S emission even exceeds their emissions of HC_7N lines. Neither the ECCC nor the WCCC can explain the new results. Shocked carbon-chain chemistry (SCCC) was proposed, which was supported by the gas-grain chemical model.

Six sources of Lupus I region, including a WCCC source Lupus I-1 and a TMC-1 like cloud Lupus I -6 (Lupus 1A) were observed with the TMRT too. The C_3S emission is weaker than all their HC_7N lines in all these sources. Except one core (Lupus I-2) with emission intensities similar to those of Lupus I-6, all were with emissions stronger than Lupus I-6, the TMC-1 like cloud. These results present that molecular complex Lupus I is the CCM-rich core gathering region second to Taurus in our Galaxy.

We also found a particular carbon-chain-producing region L1489-E with TMRT and 13.7 m telescope of Purple Mountain Observatory, Qinghai Station. It is a starless core and located at one arcmin east of the L1489 IRS. Abundant CCM emissions were detected. Its S-bearing specie emission is weak. The core is starless and dark but it is warm and in a late evolutionary status. It is not an ECCC source. The emissions are similar to those of WCCC but it is without star in forming. The core is heated by the external L1489 IRS. The new mechanism SCCC could not explain its CCM emissions too. It is a particular CCM producing region and seems to be significant for CCM science.