Fifth Workshop on Millimetre Astronomy in Italy

Report of Contributions

Contribution ID: **4** Type: **not specified**

Jan Brand, Matteo Bonato, Tiziana Venturi - Welcome speech

Monday, 12 June 2023 13:30 (5 minutes)

Introductory speech

Contribution ID: **5** Type: **not specified**

Federica Govoni - Perspectives for observations at high radio frequencies with the Italian facilities (Invited)

Monday, 12 June 2023 13:35 (15 minutes)

I will present the status of the radio astronomical facilities in Italy and the future perspectives for observations at high frequencies.

Contribution ID: **6** Type: **not specified**

Anna Miotello - ALMA updates and new capabilities (Invited)

Monday, 12 June 2023 13:50 (10 minutes)

In this talk, an overview of ALMA will be provided, with updates and explanation of the new capabilities

Contribution ID: **9** Type: **not specified**

Viviana Casasola - The Interstellar Medium in nearby galaxies (Review invited)

Monday, 12 June 2023 14:00 (30 minutes)

The Interstellar Medium (ISM) is of crucial importance for the formation and evolution of galaxies. It is in the environment from which stars are formed, the reservoir that fuels galaxy growth via star formation, the repository of material formed by stars, and a main tracer of internal and external processes affecting whole galaxies (e.g., AGN activity, galaxy interaction). For these reasons, significant efforts have been and are devoted to the characterization of the ISM in the galaxies of the Local Universe, where the proximity allows us to deeply explore the physics, the composition, and the distribution of the ISM. I will present a review of the main results emerging from recent studies on the ISM in nearby galaxies highlighting the heterogeneity of galaxy properties and the importance of resolved studies in the Local Universe in the context of galaxy evolution. Indeed, these studies also provide fundamental observational constraints to theoretical models and updated references for high-redshift studies.

Session Classification: Local Universe

Contribution ID: **10** Type: **not specified**

Alice Concas - Molecular gas and dust extinction relation revealed by ALMAQUEST

Monday, 12 June 2023 14:30 (20 minutes)

The relation between the molecular gas content and the dust screen surrounding HII regions is a powerful tool for galaxy evolution studies. In this talk, I will show how to explore such relation on a sample of 46 nearby galaxies in the framework of the ALMaQUEST (ALMA-MaNGA QUEnching and STar formation) survey, combining new CO(1-0) maps with kpc resolution from ALMA observations with IFU spectroscopic datacubes from MaNGA. I will show the existence of the empirical relation between the molecular gas surface density traced by the CO(1-0) luminosity and the dust extinction inferred by the Balmer Decrement (BD=Hα/Hβ) on a kiloparsec scale. I will discuss the possibility to use the BD to probe the spatially resolved distribution of cold gas in nearby galaxies in the absence of direct submillimeter observations.

Session Classification: Local Universe

Contribution ID: **11** Type: **not specified**

Francesco Salvestrini - Investigating molecular gas scaling relations in the local Universe: What drives the cycle of star formation?

Monday, 12 June 2023 14:50 (20 minutes)

In this work, we extend the "classical" study of the fundamental properties of galaxies tracing the cycle of star formation (SF), star formation rate (SFR), molecular gas mass (MH2) and stellar mass (M_star), by investigating the role of two more fundamental components of the interstellar medium (ISM): dust and atomic gas. We extensively investigate the scaling relations among the galaxy properties and ISM component above listed, aiming at understanding which are the conditions that makes local galaxies more molecular gas rich and, thus, more able to form new stars. To this purpose, we collect ~130 local galaxies drawn from the DustPedia sample, which benefit from a detailed and extended characterization in terms of galaxy properties, as well as a wealth collection of multiwavelength data. In particular, we select galaxies with archival low-J CO observations mapping the entire disk of the galaxies, in order to derive solid MH2 estimates (with respect to single-pointing observations with single-dish antenna), key to reduce the dispersion observed in molecular gas scaling relations. Furthermore, by using classical statistical methods, as well as a random forest regression approach, we investigate the properties of the galaxies that are responsible for the observed scatter in the most common scaling relation involving the molecular gas mass (namely, molecular gas main sequence and Kennicutt-Schmidt relation). We confirm recent results on the fundamental role of M_star in the cycle of SF, even if it loses importance as the galaxy stellar population grow older, as well as the non-secondary role of the dust component. Finally, as a by-product of this accurate study of the molecular gas scaling relation, we investigate the reliability of photometric measurements (focusing on the mid-IR e far-IR regimes) in predicting the molecular gas content observed in our sample, both at galactic and sub-kpc scales.

Session Classification: Local Universe

Contribution ID: **12** Type: **not specified**

Simone Bianchi - Exploring the mm-to-cm SED of nearby spirals

Monday, 12 June 2023 15:10 (20 minutes)

The Spectral Energy Distribution (SED) of galaxies in the mm-to-cm spectral window is the result of emission from cold dust grains, free-free, and synchrotron radiation. A multi-wavelength coverage of this range allows to disentangle the different contribution of these components, offering the possibility to investigate on the validity of current dust models and to estimate the star-formation rate without being affected by extinction. Yet, the mm-to-cm SED of galaxies is poorly known: I will discuss a case for exploring it with the instruments soon to be available at the Sardinia Radio Telescope, and present the results of a pilot SRT program to search for the Anomalous Microwave Emission, supposedly due to dust, in nearby galaxies.

Session Classification: Local Universe

Contribution ID: **14** Type: **not specified**

Davide Belfiori - Studying magnetic fields structure of the starburst galaxy NGC253 through ALMA polarization observations

Monday, 12 June 2023 16:10 (20 minutes)

The knowledge of magnetic field structure in the interstellar medium of galaxies is crucial to understand how magnetic fields influence gas dynamics and in particular their role in regulating star formation, driving galactic outflows and fuelling galactic nuclei. Given the multi-phase nature of the interstellar medium, the combination of different tracers is needed to get a complete picture. Synchrotron polarization traces mainly the hot and diffuse halo of galaxies, while polarized dust emission probes the magnetic fields in cold, dense regions of galaxies, where the star formation actually takes place. We present the analysis of ALMA polarization observations in band 4 (~140 GHz) and 7 (~300 GHz) of the central regions of the galaxy NGC253, a very well studied nearby starburst galaxy. Previous observations at cm wavelengths suggested the presence at large scale (> 0.5 kpc) of a magnetic field in the disk that is parallel to the midplane, and an X-shaped halo field centered on the nucleus. On the smallest scales (~ 150 pc) probed by radio polarisation, the magnetic field shows a vertical component aligned with the non-thermal radio filaments. ALMA band 4 observations, likely dominated by synchrotron emission, are sensitive to scales between 40 and 200pc, corresponding to the larger component of the magnetic field in the target region, overlapping with the previous radio polarisation measurements. The observations in band 7, sensitive to dust polarization, trace the magnetic field structure on spatial scales between 5 and 50 pc. This level of resolution has never been accessed before by radio polarization observations in NGC253. These high quality data allow to create a parsec scale map of the structures of the magnetic fields in the galaxy, and from the comparison of the two magnetic field tracers a more coherent picture of the role of magnetic fields in galaxies can be achieved.

Session Classification: Local Universe

Contribution ID: **15** Type: **not specified**

Federico Esposito - Modelling molecular clouds and CO excitation in AGN-host galaxies

Monday, 12 June 2023 16:30 (20 minutes)

The molecular phase of the interstellar medium (ISM) is the birthplace of stars, hence it plays a central role in the evolution of galaxies. It is also one of the main sources of accretion and obscuration for active galactic nuclei (AGN). Stars and AGN, in turn, excite the molecular gas in galaxies in a feedback process. I will present how we can study the AGN feedback at mm/sub-mm wavelengths from observations of carbon monoxide (CO) emission lines. On a new sample of local active galaxies, we inferred the contribution of far-UV radiation from stars, and X-ray radiation from the AGN, respectively producing photodissociation regions (PDRs) and X-ray dominated regions (XDRs), to the molecular gas heating. Following this, we worked a new physically-motivated model for estimating the molecular line emission in active galaxies, which takes into account the internal density structure of giant molecular clouds (GMCs), the radiative transfer of PDRs and XDRs, and the mass distribution of GMCs within galaxies. By comparing the model results with CO observations, we are able to put constraints to the relative importance of AGN and stellar radiative feedback.

Session Classification: Local Universe

Contribution ID: **16** Type: **not specified**

Ilaria Ruffa - Molecular gas kinematics in local early-type galaxies with ALMA

Monday, 12 June 2023 16:50 (20 minutes)

The unprecedented resolution and sensitivity provided by ALMA have opened up a new era in the study of massive early-type galaxies (ETGs) at low redshifts (z<0.1), enabling us to resolve the key scales over which the feeding and energetic output of their central super-massive black holes (SMBHs) operate, and thus uncovering a number of physical phenomena (e.g. nuclear bars, massive cold gas inflows/outflows). At the same time, dynamical studies of spatially-resolved molecular gas at the centre of ETGs are enabling very accurate determinations of a key intrinsic SMBH parameter, that is its mass, thus revolutionising the study of SMBH-host galaxy co-evolutionary processes.
In this talk, I will present the results obtained by analysing the kinematics of multiple CO transitions observed at high-resolution with ALMA in a number of nearby massive ETGs, hosting both active and inactive SMBHs. I will discuss how the results obtained for active ETGs provide important constraints on radio jet–cold gas interactions, and the overall SMBH fuelling and feedback processes. I will then present high-precision CO-dynamical SMBH mass measurements obtained in the context of the mm-Wave Interferometric Survey of Dark Object Masses (WISDOM) project on objects with very different types of nuclear activity, showing the enormous potential of this technique in underpinning our understanding of the SMBH-host galaxy scaling relations. Finally, I will also highlight the crucial synergy with high resolution radio continuum, neutral hydrogen, optical and X-ray observations to understand which mechanisms regulate the life-cycle of massive (active) ETGs, and the overall connection between the SMBH fuelling/feedback processes and their host galaxy evolution.

Session Classification: Local Universe

Contribution ID: **17** Type: **not specified**

Maria Vittoria Zanchettin - AGN driven winds and gaseous discs in local Seyfert galaxies: high resolution study of the multiphase ISM with ALMA, MUSE and JVLA

Monday, 12 June 2023 17:10 (20 minutes)

In this talk I will discuss the physics of the multiphase gas in local active galaxies and the impact of the Active Galactic Nucleus (AGN) on the host galaxy evolution. AGNs can generate winds and jets that interact with the host galaxy interstellar medium (ISM), potentially altering both the star formation and the nuclear gas accretion. I will focus on the cold molecular and warm ionized phases of the ISM, using ALMA and MUSE/VLT data to probe the kinematics and interaction of the different gas phases, over a broad range of physical scales. I will present a detailed dynamical modeling of the gas component through which we can reconstruct the distribution and kinematics of the multiphase discs, winds and their interaction, from nuclear out to several kp-scale. By exploiting spatially resolved sub-mm and optical emission lines, we are able to derive the best estimate of the velocity field, the spatial distribution, and electron density and therefore properly quantify both the ionized and molecular mass across the disc, narrow line region (NLR) and outflow, and their relative weight. I will present the application of our approach to the IBISCO sample, a sample of local hard-X-ray selected Seyfert galaxies. In the peculiar object NGC2992, part of the IBISCO survey, ALMA data allows to resolve a dust reservoir co-spatial with the molecular disc, therefore quantifying the gas-to-dust ratio. JVLA data shows the presence of two components, one due to expanding radio bubbles and the other due to star formation in the disc. By exploiting radio and sub-mm emission we are able to derive the spatially resolved star formation law on scales of ~200 pc.

Session Classification: Local Universe

Contribution ID: **19** Type: **not specified**

Michele Ginolfi - Understanding teenage galaxies at the end of cosmic reionization (Invited)

Monday, 12 June 2023 17:50 (25 minutes)

I will summarise recent and ongoing research highlights from the ALPINE survey, an ALMA large program that observed dust continuum and [CII] emission in a statistical sample of normal star-forming galaxies at z=4–6, highlighting their significance to our understanding of early galaxy evolution. Combined with ancillary data at UV through near-IR wavelengths, ALPINE provides the currently largest multi-wavelength sample of post-reionization galaxies and has advanced our understanding of (i) the interstellar medium properties and star formation activity, (ii) the gas content, (iii) outflows and metal enrichment of the circumgalactic medium and (v) the kinematics and merger rates, in galaxies at z>4. ALPINE builds the basis for more detailed measurements with the current and next generations of big telescopes, and I will show an overview of a number of legacy programs that are already being carried out with ALMA and JWST.

Contribution ID: **20** Type: **not specified**

Maris Assimo - Paleo-spectroscopy: retrieve and complement past data for radioastronomy searches

Monday, 12 June 2023 18:15 (20 minutes)

A plethora of microwave and millimetre wave molecular spectroscopy data are available to the radioastronomy community. However, some of it was collected several decades ago and its modelling is sometimes obsolete. Moreover, instrumental advances allow complementing the data with new measurements that extend the investigated frequency ranges and improve the quality of the spectral predictions. Therefore, retrieving and complementing past information is necessary to look for not yet detected molecules in space. Some recent cases related to molecules containing atoms of the third period will be discussed, focusing on the challenges derived by the presence of internal motions (i.e. methyl internal rotation) and preliminary searches on Alma Archive.

Contribution ID: **21** Type: **not specified**

Anna Miotello - The Disk Exoplanet C/Onnection (Invited)

Tuesday, 13 June 2023 09:00 (25 minutes)

Protoplanetary disks set the initial composition of future planetary systems. Comparing the chemistry of disks to the compositions of exoplanet atmospheres - a major priority for current space missions - informs our understanding of the planet-formation process. ALMA's unmatched capabilities have enabled huge advances in our view of disk chemistry, but our most studied systems are not representative of the exoplanet population. C2H, N2H+, and CO, have proven to be key for deriving gas-phase C/O and metallicity (C/H, O/H) via comparison with state-of-the-art astrochemical models. The ongoing DECO ALMA Large Program will observe 80 disks across four star forming regions, sampling a range of stellar masses, disk sizes, and environments to examine the disk gas compositions to search for commonalities/differences between regions and across the entire sample. This survey will revolutionize our understanding of the chemical diversity occurring in more "typical" disks and how it imprints on the diversity of exoplanet populations.

Session Classification: Planet-forming disks

Contribution ID: **22** Type: **not specified**

Francesca Bacciotti - Layered molecular outflows and disk substructures: the HL Tau case

Tuesday, 13 June 2023 09:25 (20 minutes)

The HL Tau young system includes the iconic ringed disk revealed by the first ALMA images, but also powerful outflows, in the form of a collimated atomic jet, a wide angle H2 wind and a conical CO outflow. During the recent ALMA-DOT campaign, conducted at 0.”25 resolution, we found that the CO outflow shows a peculiar substructure in the velocity channel maps, consistent with a flow arranged in nested, detached flow surfaces with decreasing velocity toward the outer layers. This distribution is in line with the flow being an extended, inhomogeneous magnetized disk-wind launched from a region between 4 and 20 au from the star. As such, the outflow would be responsible for the removal of the excess angular momentum from the intermediate disk portion in which the effective turbulent viscosity is suppressed. In addition, the outermost two layers appear to be launched from the regions immediately adjacent to the first gap. This supports recent non-ideal MHD models (e.g. Suriano et al. 2019) according to which magnetic instabilities in the disk produce at the same time inhomogeneous layered MHD winds and rings/gaps in the disk, alternatively to the action of yet elusive protoplanets. The outflow from at least three other targets show similar features to the HL Tau one. The study of such winds in the millimeter range proves therefore to be crucial for the investigation of the planet formation process.

Session Classification: Planet-forming disks

Contribution ID: **23** Type: **not specified**

Marta De Simone - Reveal the chemical history of young protostars combining mm and cm wavelengths

Tuesday, 13 June 2023 09:45 (20 minutes)

The early stages of the formation of a planetary system are represented by Solar-type protostars. Recent research suggests planet formation may begin already at these stages. Thus, the chemical content of protostars can be directly linked to what future forming planets can inherit. However, protostars are far to be fully chemically characterized. Indeed, among various protostars, a chemical diversity in their millimeter spectra has been observed and it is not well understood yet. The gaseous chemical content of protostars depends on the composition of the icy dust grain mantles formed before collapse begins. Directly measuring the ice mantle composition in these embedded objects is challenging, but it can be inferred indirectly by observing the ice major species once they are release into the gas phase during the warm protostellar stage. In this contribution, I will show the results from our VLA high spatial resolution (~300 au) observations of NH3 and CH3OH (critical ice mantle tracers). By comparing the NH3/CH3OH ratio with up-to-date astrochemical models, we were able to retrieve the chemical and dynamical history of the NGC1333 IRAS 4 protostars (De Simone et al. 2022, ApJL). The three protostars share the same history, characterized by a rapid collapse triggered by a brutal external event (De Simone et al. 2022, MNRAS), which set the observed chemistry. These findings highlight the crucial role of low frequency observations in retrieving i) the dust contribution in absorbing the molecular emission, ii) the protostellar ice mantle history, and iii) the dynamics of the protostars'birth environment. In this context, the upcoming facilities at lower frequencies (e.g., ALMA Band 1, SKA, and ngVLA) enables the observation of several complex species, with lower abundances than CH3OH, in a wavelength regime where the dust absorption is minimized, fully sampling the planet-forming protostellar region (<50 au).

Session Classification: Planet-forming disks

Contribution ID: **24** Type: **not specified**

Stefano Facchini - The physico-chemical connection between nascent planets and their birth environment (Invited)

Tuesday, 13 June 2023 10:05 (25 minutes)

The large variety of observed planetary systems is rooted in the complex physical and chemical processes that lead to their formation. In the last few years, great observational and theoretical developments have dramatically improved our understanding of how forming planets are affected by and interact with their birth environments, the protoplanetary disks. In this talk, I will focus on recent studies exploiting the outstanding ALMA sensitivity and spectral resolution to 1) unveil embedded cold Jupiters by their dynamical interaction with the gaseous formation environment; 2) characterize the main physical processes promoting planet formation; 3) constrain the chemical inventory of fundamental molecules in the terrestrial planet forming regions. I will finally show how in synergy with IR observations (JWST, VLT, upcoming ELT) these new ALMA data and analysis techniques have the potential to calibrate the mass-luminosity relationship of new-born planets.

Session Classification: Planet-forming disks

Contribution ID: **25** Type: **not specified**

DISCUSSION on planet-forming disk science led by Davide Fedele and Giovanni Rosotti

Tuesday, 13 June 2023 10:30 (30 minutes)

Session Classification: Planet-forming disks

Contribution ID: **26** Type: **not specified**

Claudio Codella - Astrochemistry of Galactic regions: living ALMA, preparing SKA (Review Invited)

Tuesday, 13 June 2023 11:55 (30 minutes)

Astrochemistry of Galactic regions is living a golden age. More specifically, the study of thesocalled interstellar Complex Organic Molecules (iCOMs, mainly O-bearing species with at least 6atoms), considered the simplest bricks needed to have pre-biotic environments, has benefited ofrecent improvements of observational tools. On the one hand, single-dish spectral surveys withtelescopes observing at cm-wavelengths (mainly GBT, and Yebes), once equipped with improvedbackends, increased the number of complex species detected in the interstellar medium (ISM). Onthe other hand, the advent of the ALMA (sub-)mm interferometer, with its unique combination ofhigh sensitivity, high angular resolution, and large spectral coverage, boosted both the detections ofiCOMs and the imaging of their spatial distributions. iCOMs are almost ubiquitous in the ISM,being observed in a wide variety of astronomical environments and physical conditions: in bothcold molecular clouds and hot regions, in the Galactic disk as well as in the Galactic Center. In this context, we will review the power of ALMA in shedding light on the chemistry atwork during the earliest phases of low-mass star formation. The role of the pre-solar chemistry inthe composition of the Solar System bodies is far to be understood. Key questions still to beaddressed are: how chemically organic complex are the volatiles delivered to the pristine planetaryatmospheres? What molecules are passed from the large-scale envelope to the disk in which planets,comets, and asteroids form? As a matter of fact, molecular complexity builds up at each step of theprocess leading to star formation, ending up in prebiotic molecules. Indeed, one of the breakthroughresults found by ALMA has been imaging iCOMs emission in protostellar and protoplanetary disks.Finally, we will also discuss the limits of ALMA observations, paradoxically due to the high spatialresolution reached: the iCOMs detection is hampered by the high-opacity continuum in the diskmidplane, i.e. the region where planets are expected to form. This is a limit of the ALMA datasetsthat further submm observations will never overcome. Only high spatial resolution (< 10 au)observations at much lower frequencies, at cm-wavelengths, where the dust continuum is morelikely to be optically thin, will be able to provide the answer, paving the way to the arrival of SKA.

Session Classification: Milky Way

Contribution ID: **27** Type: **not specified**

Giovanni Sabatini - First ALMA maps of cosmic ray ionization rate in high-mass star-forming regions

Tuesday, 13 June 2023 12:25 (20 minutes)

Low-energy cosmic rays (<1 TeV) are a pivotal source of ionisation of the interstellar medium, where they play a central role in determining the chemical gas composition and, in turn, in influencing the formation of stars and planets. Observations of H_3^+ absorption lines in diffuse clouds – n(H_2)~10^2 cm^{-3} – have been used for decades to provide reliable estimates of the cosmic ray ionisation rate relative to molecular hydrogen (ζ_{H2}). However, in denser clouds where stars and planets form, this method is often inefficient since H_3^+, similar to H_2, does not emit rotational lines as it does not have a permanent electric dipole. The ζ_{H2} estimates are, therefore, still provisional in this context, and represent one of the least understood ingredients when it comes to defining general models of star formation. Recently, a new analytical approach to estimate ζ_{H2} in the densest regions of molecular clouds has been proposed by Bovino et al. (2020), based on observations of ortho-H_2D^+ as the main observational constraint to derive the amount of H_3^+. This has been applied by Sabatini et al. (2020) in a large sample of high-mass star-forming regions. Exploiting the exceptional observational capabilities of ALMA, in this talk I will present the first high-resolution maps of ζ_{H2} in two massive clumps. I will present these results and the way they provide crucial constraints for the chemical/physical modelling of star-forming regions.

Session Classification: Milky Way

Contribution ID: **28** Type: **not specified**

Andrea Giannetti - Methanol to the rescue: estimating volume density of molecular gas

Tuesday, 13 June 2023 12:45 (20 minutes)

Estimates of volume densities (n_H2) are still very uncertain, despite being fundamental to determine the stability of molecular condensations on all scales, from clouds to cores, to protostellar- and protoplanetary disks, their energy balance, and their chemical evolution. While in principle it is easy to use molecular emission to infer the density of the emitting gas, in practice these estimates depend critically on the temperature and chemical stratification of the tracer, and on the calibration accuracy of the data. Therefore, another method has been designed as the default: the volume density is estimated from the column density of H2, derived from dust emission, using as the spatial extent along the line-of-sight the average size of the object projected on the plane of the sky. This method too is plagued by significant uncertainties. The results rest on simplistic assumptions about the geometry of the object (spherical, cylindrical, etc.), that do not even consider the observed aspect ratios on the plane of the sky, let alone the uncertainty of the gas-to-dust ratio. To overcome this impasse, we developed a new framework to estimate n_H2 from CH3OH line ratios, independently of geometry and of temperature distribution. CH3OH uniquely offers lines that are quasi-exclusively sensitive to the density and can be observed in a single tuning, removing calibration uncertainties. Methanol is also widespread, tracing both cold and hot gas, making this probe ideal to be used on most scales and stages of star- and planet- formation. Our framework will bring comparisons between models and observations to an entirely new level by mapping the density distribution (e.g. helping to determine the stability of molecular fragments, their mass independently of the temperature, and their chemical evolution), and will allow to reconstruct the 3D structure of molecular condensations, revealing the intimate details of the star-formation process.

Session Classification: Milky Way

Contribution ID: **29** Type: **not specified**

Olga Bayandina - ALMA study of G11.92-0.61: disk-wind or YSO multiplicity?

Tuesday, 13 June 2023 16:20 (20 minutes)

G11.92-0.61 MM1 is considered to be one of the best known examples of a forming proto-O star, with an accretion disk and outflow marked by various tracers. However, the more detailed structure of the region remains unclear. A comparison of the molecular line and water maser data reveals disparity in their velocity patterns, which can be explained either by the presence of a disk wind or by the binary structure of the system. An extensive survey of the ALMA Band 6 spectral lines was carried out to clarify the picture. In this talk, we will present the first results we obtained establishing the physical parameters and kinematics of the accretion disk on scales from 50 au up to 1000 au, as well as disk wind in G11.92-0.61 MM1.

Session Classification: Milky Way

Contribution ID: **30** Type: **not specified**

Sergio Molinari - Galaxy-wide star formation: zooming in from panoramic Galactic Plane surveys to 1000au-scale with ALMA (Review Invited)

Tuesday, 13 June 2023 14:00 (30 minutes)

The process of star formation is governed by the interplay of often competing physical agents such as gravity, turbulence, magnetic fields, and radiation. The ISM is organized in a hierarchy of scales, that connect the disk of the Milky Way as a whole, through filamentary atomic/molecular star-forming clouds to dense and fragmenting clumps, and eventually to cores and protoplanetary disks. At the same time, the momentum and energy input from stars, in form of radiation, winds and supernovae, creates highly non-linear feedback loops that strongly influence the behavior of the system across the entire cascade of scales. This depicts the Milky Way as a complex ecosystem where dramatically different environments coexist and where varying conditions are found for star and planet formation, and ultimately for life. Exploring and understanding our Galactic ecosystem as well as the physical processes that govern its evolution is the primary research goal of the ECOGAL Project, in which observations and numerical simulations come together to address fundamental questions about: i) how the different phases of the ISM form and evolve, ii) identify the processes that govern the build-up and fragmentations of dense filamentary clouds, iii) what are the agents responsible to drive the mass flow through spatial scales onto the dense parsec-scale clumps, and finally iv) what are the physical processes governing the clump-to-core fragmentation, how do cores gain their mass and how they evolve with time. In a zoom-in view from the Galactic disk, down to the 1000au scale where dense cores are resolved, I will present an overview of the preliminary results that ECOGAL is obtaining by joining forces between large-scale atomic, molecular lines and far-infrared Galactic single-dish surveys, with statistically significant ALMA surveys. In particular I will present a first overview of the results of the ALMAGAL large project, a “statistical”survey of 1000 dense (> 0.1 g/cm2) and massive (M>500 M_sun) parsec-scale clumps resolved at a minimum linear scale of 1000au, sampling the full evolutionary path from IRDCs to UCHII regions from the tip of the Galactic Bar to the Solar circle and beyond. I will conclude with some perspectives about ongoing numerical modelling campaigns and possible future surveys with MeerKAT/SKA, proposed balloon-borne far-infrared polarimetry and more.

Session Classification: Milky Way

Contribution ID: **31** Type: **not specified**

Milena Benedettini - The Forgotten Quadrant Survey: a 12CO and 13CO (1–0) survey of the Galactic Plane in the range 220°<l<240°, -2.5°<b<0°

Tuesday, 13 June 2023 14:30 (20 minutes)

I will present the Forgotten Quadrant Survey (FQS), a project that used 700 hr of the 12m antenna at the Arizona Radio Observatory to map a strip of the Milky Way plane in the range 220°<l<240° and -2.5°<b<0°, both in 12CO and 13CO (1–0). These data show how the molecular dense gas is organised at different spatial scales: from the spiral arms, traced by the giant clouds with their denser filamentary networks, down to clumps and cores that host new-born stars. From these high-quality spectroscopic data we can derive the distance of the emitting gas and obtain reliable estimates of its key physical parameters such as size, mass and virial parameter. Catalogues of molecular clouds are produced self-consistently by using the FQS data of the two transitions. They contain 263 and 87 structures for the 12CO(1-0) and 13CO(1-0) catalogues, respectively, that is many more molecular clouds than previously found in the same area by older surveys. Indeed, the sensitivity, spatial and spectral resolution of FQS data allow us to detect not only the classical giant molecular clouds, but also small clouds, namely sub-parsec structures that cannot be in gravitational equilibrium and are likely transient or confined by external pressure, and to resolve the clouds structure at the sub-parsec scale up to a distance of a few kiloparsec. I will present the statistical properties of the physical parameters of the molecular clouds and compare the results of the two FQS catalogues. The comparison shows that the structures traced by 13CO are overall less extended and less massive than the molecular clouds identified in the 12CO (1–0) data-set, since they trace the brightest and densest part of the 12CO (1–0) clouds. Conversely, the distribution of aspect ratio, equivalent spherical radius, velocity dispersion and virial parameter in the two catalogues are similar. I have also studied the variation of the mass surface density of molecular clouds with the galactocentric radius between 1 and 15 kpc, complementing the FQS catalogues with other two catalogues of molecular clouds extracted from similar CO surveys, the GRS and the SEDIGSM catalogues. I find that, even if the mass surface density of molecular clouds spans about an order of magnitude over the single clouds, its mean value is almost constant across the galactocentric radius, indicating that this parameter, which is a proxy of star formation, is highly influenced by local conditions.

Session Classification: Milky Way

Contribution ID: **32** Type: **not specified**

Alessio Traficante - The SQUALO-ALMA project: clump-fed accretion mechanism in high-mass star-forming objects

Tuesday, 13 June 2023 14:50 (20 minutes)

The formation mechanism of the most massive stars is far from completely understood. It is still unclear if the formation is core-fed or clump-fed, i.e. if the process is an extension of what happens in low-mass stars, or if the process is more dynamical such as a continuous, multiscale accretion from the gas at parsec (or even larger) scales. In this context I will present the results obtained from the 1.3 mm continuum data of the SQUALO (Star formation in QUiescent And Luminous Objects) project (Traficante+23, MNRAS, 520, 2306. doi:10.1093/mnras/stad272). SQUALO is an ALMA survey designed to investigate the properties of 13 massive clumps selected at various evolutionary stages and with the common feature that they all show evidence for accretion at the clump scale. Our observations identify 55 fragments with masses in the range 0.4 ≤ M ≤ 309 M⊠, with evidence that the youngest clumps already present some degree of fragmentation. The data show that physical properties such as mass and surface density of the fragments and their parent clumps are tightly correlated. Quite interestingly, the minimum distance between fragments decreases with evolution, suggest a scenario in which massive clumps first fragment under the influence of non-thermal motions driven by the competition between turbulence and gravity. With time gravitational collapse takes over and the fragments organize themselves into more thermally supported objects while continuing to accrete from their parent clump. Overall, our results support a dynamical, clump-fed scenario in which the properties of the parent clumps at the parsec scales strongly influence the formation history of the inner fragments identified with a resolution of few thousands of AU.

Session Classification: Milky Way

Contribution ID: **33** Type: **not specified**

Marco Monaci - High Latitude Molecular Clouds chemodynamics using high-resolution multiline spectroscopy

Tuesday, 13 June 2023 15:10 (20 minutes)

High latitude molecular clouds (HLMC) with no evidence of star formation and generally clear line of sight are the among the best sites to study the dynamics of the the Cold Neutral Medium (CNM) because of the high spatial sampling offered by their proximity. We focus on MBM 40, a non-star forming diffuse cloud, highlighting principal results using a variety of molecular transitions observed with high spatial (0.01 pc) and velocity (0.07 km/s) resolution spectroscopic maps of selected areas in 12CO, 13CO (1-0), CH, HCO+, H2CO and fully sampled high velocity resolution mapping in 12CO (1-0) from FCRAO. We present a new dynamical analytical approach, considering each profile as a line of sight Probability Distribution Function (PDF) of the turbulence, combind with centroid correlation studies and HI 21 cm observations (GALFA). The relation between dust, molecular and atomic gas is also studied, with new hints on the topological structure of the cloud as reflected in the velocity gradients.

Session Classification: Milky Way

Contribution ID: **34** Type: **not specified**

Alessandro Coletta - Fragmentations of ALMAGAL dense clumps in young protoclusters

Tuesday, 13 June 2023 16:00 (20 minutes)

A large fraction of stars forms in clusters which also include high-mass stars (Mstar ≥ 8 Msun). Yet the physical mechanisms regulating the fragmentation of dense molecular clumps into star-forming cores and its outcome are still under debate. Millimeter/sub-millimeter wavelength observations are ideal probes for this investigation. The ALMAGAL large project survey offers the possibility to study the high-mass star formation process with an unprecedented level of detail and statistical significance, featuring high-resolution ALMA millimeter observations of more than 1000 dense clumps selected from the Herschel Infrared Galactic Plane Survey (Hi-GAL) at different Galactic locations (from the Central Bar to spiral arms in the outer Galaxy), which cover a wide range of masses (~10^2<M<10^4 Msun), heliocentric distances (~2-8 kpc), surface densities (~0.1-15 g cm^-2) and evolutionary stages (from IRDCs to HII regions, with the evolutionary indicator ~0.05<L/M<500 Lsun/Msun). In this talk, we present results of the analysis carried out on 1.4 mm ALMA continuum images of the whole ALMAGAL sample, with a maximum angular resolution of ~0.15”(≤ 1000 AU at ~6 kpc distance) allowing to reveal dense fragments down to the typical core scale. We performed the compact source extraction procedure with the CuTEx algorithm to obtain the catalog of dense fragments, and applied the same procedure on populations of injected synthetic sources in order to estimate the flux completeness limit and photometric accuracy of our catalog. We characterized the revealed population of fragments in terms of detection statistics and numerical distribution, and derived their main physical parameters, also taking into account potential observational biases that could affect our results. We report a total of ~6000 detections distributed in ~80% of the targets, each showing a number of fragments between 1 and ~50 (with a median of ~5). The estimated sizes of the fragments range from ~800 to ~3000 AU, and masses from ~10^-2 to ~10^2 Msun, respectively. Thanks to the robust statistics available we are able to properly address the relationships that link the degree of fragmentation, the mass distribution and spatial density of the cores, to the density and evolutionary stage of the hosting clumps. These results will also be discussed in the framework of current numerical simulations of clump fragmentation.

Session Classification: Milky Way

Contribution ID: **35** Type: **not specified**

DISCUSSION on Galactic science led by Milena Benedettini and Eleonora Bianchi

Tuesday, 13 June 2023 16:40 (30 minutes)

Session Classification: Milky Way

Contribution ID: **36** Type: **not specified**

Chiara Mininni - Molecular vs continuum emission: a morphological comparison in ALMAGAL clumps

Tuesday, 13 June 2023 17:10 (20 minutes)

The analysis of the line emission at millimeter wavelengths is a powerful tool for studying the kinematic and thermal conditions of the gas in star-forming regions. However, the question of how well different species trace the emission of dust in the continuum at various scales has been addressed in the literature either by comparing the region of emission of the different lines with the region emitting in the continuum or by using intensity correlators, such as Pearson's coefficient. In this work, we present an innovative approach to this problem based on the analysis of the correlation between the morphology of the moment-0 maps of lines from seven of the most common molecular species observed in high-mass star-forming regions and the continuum emission from dust at 1.4 mm on an unprecedented statistically robust sample. The observations are part of the ALMAGAL program, which has observed more than 1000 candidate high-mass star-forming clumps selected from the Herschel Infrared Galactic Plane Survey (Hi-GAL) catalogue (Elia et al. 2017, 2021), with the ALMA interferometer at 1.4 mm. Observed clumps have masses above 500 M⊙, distances up to 7.5 kpc, and cover different evolutionary stages and fragmentation properties. The morphological analysis we carried out is based on the astroHOG package (Soler et al. 2019), developed to compare the morphology of astrophysical images, or cubes, using the method of the histogram of oriented gradients (HOG). The HOG method is a machine vision tool that uses the intensity gradient orientation to characterise the similarities between two images and evaluates whether the relative gradients in the two images are randomly oriented or preferentially parallel (i.e. the distribution of the angles between the direction of the two gradients peaks around 0◦), implying that the morphology of the two images is similar. Across the subsample of 550 ALMAGAL clumps analysed, only the emission of H2CO, CH3OH, and SO transitions significantly overlap with the continuum diffuse emission. Still, the astroHOG comparison reveals that the morphology is poorly correlated. We also run astroHOG over a masked portion of the continuum emission that corresponds only to the densest regions. In this case, we found that the analysed species can be divided into two groups. CH3CN, DCN, and HCCCN show a good correlation, while for H2CO, CH3OH, SO, and SiO, the emission mostly does not follow the morphology of the dense part of the continuum. Analysing the ALMAGAL data with the astroHOG method and Pearson's coefficient, the most widespread tool used for comparing the emission of different tracers in the literature, the former gives more accurate and reliable results.

Session Classification: Machine learning, analysis tools

Contribution ID: **38** Type: **not specified**

Ivano Baronchelli - UMLAUT: A Data-Driven Machine Learning Approach with Automated Parameter Tuning and Outlier Detection (Invited)

Tuesday, 13 June 2023 17:30 (25 minutes)

UMLAUT (Unbiased Machine Learning Algorithm Using Topology) is a versatile machine learning algorithm initially developed as a variant of the highly efficient K-Nearest Neighbors (KNN) algorithm, known for its effectiveness in handling large datasets. While originally designed for the automatic classification of single emission lines, UMLAUT possesses remarkable potential that extends far beyond its initial application.
The algorithm combines diverse sources of information, automatically identifying the most relevant ones, and enabling dimensionality reduction in problem-solving. With the inclusion of a modified DBSCAN-like module, UMLAUT facilitates the automatic identification of spurious sources and the discovery of new types of sources or data points not originally present in the training set. It can be used for regression, classification, and for the identification of different groups. UMLAUT is available in multiple programming languages and can be integrated into various algorithms, allowing users to combine it with different machine learning techniques. Its adaptability and versatility render it applicable to a wide range of contexts and problems, including sub-mm astronomy.

Session Classification: Machine learning, analysis tools

Contribution ID: **39** Type: **not specified**

Andrea Ferrara - The Earliest Dusty Galaxies. Lessons from ALMA and JWST (Review Invited)

Wednesday, 14 June 2023 09:00 (30 minutes)

One of the major surprises provided by the first months of early Universe observations by JWST has been the detection of a stunning overabundance of luminous, and likely massive, galaxies at redshift z>10. As the first spectroscopic confirmations are accumulating, it is crucial and timely to investigate these important and yet unknown aspects of early galaxy formation and evolution. At a time at which ALMA has laid the foundations of our understanding, Webb seems to hint at a possibly conflicting scenario. These (apparent?) contradictions need to be solved in the framework of studies that combine theory, cosmological simulations and the most advanced IR/sub-mm observations. I will analyze the possible new scenarios and propose some preliminary answers to the above questions.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **40** Type: **not specified**

Roberto Decarli - The physics of the ISM in quasars at z>6

Wednesday, 14 June 2023 09:30 (20 minutes)

Quasars at cosmic dawn (z>6) are some of the most active sources in the early Universe. The rapid accretion of gas onto the already assembled massive black holes (~1e9 Msun) and the intense consumption of gas through rapid star formation release enormous amount of energy onto the interstellar medium, setting up unique conditions that are not present in the local Universe. Multi-line studies of the ISM using ALMA and other mm-wavelength facilities offer a unique insight on these conditions, where we can probe the baryon cycle in these early quasars, the balance between inflows, accretion, outflows, star formation, and feedback. We examine the case of the quasar PJ183+05 observed at z=6.4, where all the gas phases can be studied in detailed via a comprehensive ALMA study. Finally, we discuss the perspective of a synergy between ALMA and JWST in unveiling the physical properties and the astrophysical processes at work in the build-up of the first quasars.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **41** Type: **not specified**

Laura Sommovigo - Fast and Furious: the dust enrichment of the early Universe

Wednesday, 14 June 2023 09:50 (20 minutes)

The recent ALMA large program REBELS has provided us with the first statistical sample of dusty galaxies at the Epoch of Reionization (EoR). Despite REBELS sources being selected as UV bright, we found that some are strongly dust-obscured (obscured SFR \sim 90%) and surprisingly dust-rich (Md/Mstar \sim 1e-2). These results have led us to question whether short-lived Supernovae alone are efficient enough to enrich the earliest, massive galaxies in our Universe. Now enters the JWST tentative discovery of a population of super-early (z>10), relatively massive and evolved galaxies, which nevertheless show blue (β <−2.6) spectra and little to no dust attenuation. A possible explanation is that these super early galaxies are in fact relatively dusty, but they exhibit a multi-phase, spatially-segregated ISM, where unattenuated UV and IR continuum emission can co-exist. Such ISM morphology has already been inferred for some peculiar z=5-7 sources within the REBELS and ALPINE samples. This spatially-segregated scenario is partially questioned by the lack of any dust continuum detection where ALMA follow-up of the z>10 candidates has been attempted. Thus, our favoured explanation is that in these bursty sources, dust is produced but shortly after ejected due to strong radiation pressure. Future ALMA and JWST observations, including spectroscopic confirmation of these z>10 candidates, will help us investigate this further, probing whether the dust/metal enrichment of the Universe skyrockets within the little time span of \sim 200 Myr (between z=10 and z=7). The unprecedentedly detailed observations possible with JWST and ALMA synergy urge us to improve our modelling of dust obscuration processes and the dust/metals build-up at high-z. Only then we can produce a cohesive picture of the earliest, tumultuous phases of galaxy evolution.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **42** Type: **not specified**

Cecilia Bacchini - 3D modelling of the molecular gas kinematics in optically-selected jellyfish galaxies

Wednesday, 14 June 2023 10:10 (20 minutes)

Cluster galaxies are subject to the ram pressure exerted by the intracluster medium, which can perturb or even strip away their gas while leaving the stars undisturbed. Interestingly, both observational and numerical studies find that the ram pressure, by compressing the gas disc, may drive gas inflows towards the galaxy center, possibly feeding the black hole activity. We study the distribution and kinematics of the molecular gas, traced by CO, in four late-type cluster galaxies observed with ALMA. These objects were selected as they show tails of atomic and ionized gas, which indicate ongoing ram pressure stripping. We modelled the CO emissione line datacubes using the software 3D-Barolo, searching for signatures of radial gas flows, ram pressure stripping, and other perturbations. We compare the results with the stellar kinematics extracted from MUSE@VLT observations, obtaining useful insights about the physical mechanisms affecting our galaxies. Overall, we find that the molecular gas is more resilient to ram pressure than the diffuse gas phases. Typically, the molecular gas kinematics is mainly dominated by bar perturbations and/or rotation, while the ram pressure becomes important at large galactocentric distances. Large-scale radial flows of molecular gas are present and consistent with bar-driven inflows or ram pressure-driven outflows. Despite all our galaxies host an AGN, no molecular gas outflow is clearly visible. The molecular gas velocity dispersion tends to be enhanced with respect to field galaxies, indicating strong turbulence. This can be due, either directly or indirectly, to the ram pressure, which can increase the gas turbulent energy and/or the star formation rate, enhancing the turbulence driven by supernova feedback.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **44** Type: **not specified**

Sirio Belli - Cold Gas in High-Redshift Quiescent Galaxies (Invited)

Wednesday, 14 June 2023 10:30 (25 minutes)

The most massive galaxies were the first to shut off their star formation, turning into quiescent systems when the universe was still young. This quenching process is still poorly understood, and to make progress it is crucial to study the role played by cold gas. I will present two different ways in which this can be done. Using millimetric observations with NOEMA, we detected CO line emission from three massive quiescent galaxies at z~1, and measured low gas masses. This suggests that quenching consists in the removal of cold gas rather than in the suppression of star formation efficiency. I will also present new results based on James Webb Space Telescope observations, in which we detect neutral atomic gas in a high-redshift quiescent galaxy using rest-frame optical absorption lines. I will illustrate the implications of this detection for models of galaxy quenching.

Contribution ID: **45** Type: **not specified**

Stefano Carniani - CGM enrichment by quasar-driven outflows

Wednesday, 14 June 2023 11:25 (20 minutes)

Large scale outflows are believed to be an important mechanism in the evolution of galaxies, as they can both suppress and enhance star formation as well as eject gas from their host galaxies and mix the pristine gas from the intergalactic medium and processed material from the galaxy in the circum-galactic medium (CGM). We can study the impact of these large-scale outflows either by tracing the current outflows (by studying broad emission line profiles), or by studying the impact of past outflows on the gas surrounding the galaxy. In this work, we examined the CO(7-6), CI, H2O (806 GHz) and dust continuum ALMA observations of quasars at z~2.3. By investigating the radial surface brightness profiles of both the individual sources and the stacked emission, we detect extended cold gas and dust emission on scales of ~14 kpc in CO(7-6), CI, and dust continuum. We have further confirmed our results by investigating the visibilities of individual targets and the stacked visibilities These results reveal the impact of large scale outflows on the CGM around extremely powerful quasars.

Session Classification: Galaxies and AGNs

Contribution ID: **46** Type: **not specified**

Federico Lelli - Cold gas dynamics in high-z galaxies

Wednesday, 14 June 2023 11:45 (20 minutes)

High-resolution ALMA observations have opened a new window to study galaxy dynamics at z>1 using cold gas tracers, such as CO, [CI], and [CII] emission lines. In this talk, I will present in-depth studies of individual galaxies at z=1-5 with ALMA data at angular resolutions between 0.05”-0.5”. In such galaxies, the cold gas forms dynamically-cold rotation-supported disks with high rotation-to-dispersion ratios, in contrast to the common picture of “turbulent” high-z disks from H-alpha data. In most cases, the galaxy rotation curve is flat and requires the presence of a central mass concentration (a stellar bulge) in addition to a pure exponential disk. Finally, I will present preliminary results from the TRICEPS project: a [CII] survey of 15 massive galaxies at z=4-5 with spatial resolutions of only 0.5-1.0 kpc. The TRICEPS data show that rotating gas disks are common in massive galaxies (Mstar~10^10-10^11 Msun) at z=4-5, living during the first 1.5 Gyrs of the Universe’s lifetime. Overall, the ALMA data suggest that massive galaxies must have formed and evolved surprisingly fast, in analogy to recent independent results from JWST.

Session Classification: Galaxies and AGNs

Contribution ID: **47** Type: **not specified**

Violette Impellizzeri - EHT & ALMA: a view of the local Universe (Invited)

Wednesday, 14 June 2023 12:05 (25 minutes)

MmVLBI has revolutionised our view of black holes and have provided some of the most striking, high resolution images obtained by mmVLBI, like the first images of a supermassive black hole obtained by the Event Horizon Telescope collaboration (EHTC). But beyond these two best studied targets, M87 and SgrA*, the EHTC has been exploring a variety of nearby AGN allowing to study different local environments and jet properties. In this talk I will present an overview of the AGN that are targeted with mmVLBI at 1.3mm and 3mm, highlighting some of the recent results that have been obtained. MmVLBI is a powerful tool not only for observations of the accreting material at tens of muas resolution, but will be critical - especially as more baselines become available around the globe - to study jet launching mechanisms and how these connect to the more extended jet material which is studied with cmVLBI at mas resolution.

Contribution ID: **48** Type: **not specified**

Discussion on extragalactic science led by Laura Pentericci and Livia Vallini

Wednesday, 14 June 2023 12:30 (30 minutes)

Contribution ID: **50** Type: **not specified**

Toby Devereaux - Star-forming clumps and their molecular gas content

Wednesday, 14 June 2023 14:20 (20 minutes)

The peak of galactic star formation occurs between a redshift of 1-3. Galaxies at these redshifts are shown to be dominated by irregular clumpy morphologies. These clumps are suggested to be starbursting and are thought to play a significant role in the growth of the bulge and subsequent evolution of the galaxy itself. Despite being observed in bright UV wavelengths and optical emission lines, these star forming clumps have not been significantly detected in molecular gas observations at this redshift. As these clumps are actively star forming, it begs the question; where is the fuel (molecular gas) for star formation in these clumps? BX610 has canonically been described as a typical clumpy galaxy at the epoch of cosmic star formation (z=2.21). BX610 has been well observed with both SINFONI and HST probing the stellar emission, star formation and warm ionised gas, and a clumpy morphology has been found in both tracers. We present ALMA observations, at exquisite resolutions of 0.085”-0.155”(matching the HST and SINFONI+AO observations), targeting the compact CO(4-3) and CO(7-6) line emission and dust continuum - at sufficiently high sensitivity to detect the clumps. I will present the detection of some clumps in CO, whereas other clumps remain undetected, and discuss the reasons and specific scenarios for this observation.

Session Classification: Galaxies and AGNs

Contribution ID: **51** Type: **not specified**

Francesca Perrotta - H2O emission lines in a strongly lensed dusty star-forming galaxy at z ~ 3.1

Wednesday, 14 June 2023 14:40 (20 minutes)

We report ALMA high-resolution observations of water emission lines $p-\mathrm{H_2O}(2_{02}-1_{11})$, $o-\mathrm{H_2O}(3_{21}-3_{12})$, $p-\mathrm{H_2O}(4_{22}-4_{13})$, in the strongly lensed galaxy HATLASJ113526.2-01460 at redshift z $\sim$ 3.1. From the lensing-reconstructed maps of water emission and line profiles, we infer the general physical properties of the ISM in the molecular clouds where the lines arise. We analyze the relative contributions of Far Infrared pumping and collins in water lines excitation. Our findings are also supported by the detection of the medium-level excitation of CO resulting in the line emission CO (J=8-7). Thanks to the unprecedented high resolution offered by the combination of ALMA capabilities and gravitational lensing, we discern the different phases of the ISM and locate the hot molecular clouds into a physical scale of $\sim$ 500 pc. We discuss the possibility of J1135 hosting an AGN in its accretion phase and the relation between the water emission lines and the total infrared luminosity of J113526.2, as well as the SFR as a function of water emission intensities, comparing the outcomes to local and high-z galactic samples from the literature.

Session Classification: Galaxies and AGNs

Contribution ID: **52** Type: **not specified**

Gayathri Gururajan - Probing the gas reservoirs of high-redshift lensed dusty

Wednesday, 14 June 2023 15:00 (20 minutes)

The discovery of dust-enshrouded star-forming galaxies in the early Universe has opened new questions in understanding the formation and evolution of galaxies through cosmic times. With the breakthrough in sub millimeter astronomy spearheaded by facilities like Atacama large millimeter/sub-millimeter array, a large diversity in the population of dusty star-forming galaxies (DSFG) has been revealed with some of them hosting prodigious star-formation rates (~500 Msun/yr). Such galaxies play a vital role in understanding the rapid formation and stellar mass assembly of massive galaxies in the early Universe. Characterising the gas reservoir and the interstellar medium (ISM) of these galaxies can give us key insights into their star-forming mechanisms. We present a sample of 29-lensed DSFGs at 1.8<z<4.5, targeted for [CI] observations to estimate the gas content of these DSFGs and present a comparison and cross-calibration between 4 tracers of molecular gas content : CO, [CI], [CII] emission lines and the dust content of a galaxy. The main goal of this work is to check the consistency between the gas mass tracers and cross-calibrate them, but do not provide the absolute values of these tracers which would require us to implicitly assume the value for one of them. We then target 3 such DSFGs with ALMA high-resolution (~0.4") to obtain insights on the resolved gas reservoirs and ISM of the sample. We probe the ISM properties such as density and radiation field intensity using [CI] to mid- or high-J CO lines and [CI] to infrared luminosity ratio. In the case of the large sample, we find that our sample has ISM parameters in comparison to the literature SMG populations. We also find the median excitation temperature of [CI] in the ISM is higher than that of the literature SMGs. We find a good agreement between the various molecular gas mass tracers and provide cross-calibrations for these tracers. With the higher resolution sample, we find a large heterogeneity in the radiation field and density of the ISM in our sample, although their global values are similar to the other SMGs. We model the lensing configuration for our sample and find no strong evidence of differential magnification for our sample. We compute the dynamical mass of these galaxies and find that a ULIRG-like value of the CO-to-H2 conversion factor is more agreeable with the estimated dynamical masses.

Session Classification: Galaxies and AGNs

Contribution ID: **53** Type: **not specified**

Marika Giulietti - Synergistic Study of High-z Strongly Lensed Dusty Star-Forming Galaxies with ALMA: Insights into Galaxy/AGN Co-evolution

Wednesday, 14 June 2023 15:20 (20 minutes)

Co-evolutionary models between supermassive black holes and their host galaxies predict that processes in the early stages of galaxy formation, such as nuclear activity and star formation, are strictly related and coordinated in time. Dusty star-forming galaxies (DSFGs) are ideal laboratories to test this scenario, as they constitute the bulk population at the peak of cosmic star formation, and they are identified as the progenitors of massive quiescent early-type galaxies. Gravitational lensing offers the unique opportunity to access the details of the physical properties, morphology, and interstellar medium content of these compact and obscured objects. In this talk, I will present the study of a sample of sub-mm-selected, high-redshift, strongly lensed DSFGs, highlighting the synergy between their radio and far-IR emission with ALMA archival data to investigate the interplay between nuclear activity and star formation. Finally, I will focus on a target among the sample showcasing a lack of clear optical/NIR emission for both the lens and the background source. ALMA high-resolution observations enabled the un-lensed morphology reconstruction of the background galaxy, resolving the compact (~500 pc) star-forming region and gas distribution (~1 kpc) from the [CII] and CO(8-7) spectral line emissions and shedding light on the evolutionary stage of this peculiar object.

Session Classification: Galaxies and AGNs

Contribution ID: **54** Type: **not specified**

Claudia Di Cesare - Metal enrichment in the CGM around high-z merging galaxies

Wednesday, 14 June 2023 16:10 (20 minutes)

We study the emission of the [CII]158 Xm from the gas sourrounding merging systems at 4 ≤ z ≤ 6 (post Reionization Epoch), when galaxies rapidly assembled their masses and reached their chemical maturity. It has now become clear that galaxies are complex ecosystems, continuously exchanging material with the surrounding environment, and understanding the physical mechanisms that drive galaxy evolution at these remote cosmic epochs, requires an appropriate combination of observational and theoretical tools. The observational part of this work makes use of major merger systems present in the ALMA Large Program to Investigate [CII] at Early times (ALPINE) survey, which is designed to measure [CII] and the FIR-continuum emission for a sample normal galaxies at z = [4.4-5.8]. In particular, we consider and analyse merging systems whose components can be spatially and/or spectrally resolved, so that we can distinguish between the [CII] emission coming from the single components of the system and that coming from the system as a whole, this distinction between emissions help us understanding the metal enrichment of the circumgalactic medium (CGM) around the selected candidates. How much of the [CII] emission is coming from the components of the merging system? And from the gas surrounding the system? We then, make use of the hydrodinamical cosmological simulation dustyGadget (Graziani+2020) to select synthetic analogues of observed galaxies, which help us interpret observational results. Indeed, simulated counterparts give us hints on the feedback processes regulating baryon cycling at the CGM scale and on the role of outflows and gas stripping in merging systems. In the end, the comparison between simulated and observed galaxies gives us information on how these early galaxies acquire their gas content and get enriched with metals and dust grains.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **55** Type: **not specified**

Eleonora Parlanti - Evidences for turbulent disk galaxies at z > 5

Wednesday, 14 June 2023 16:30 (20 minutes)

Primeval galaxies are supposed to be subjected to galaxy-galaxy interactions, merging processes, gravitational instabilities, and feedback from both bursts of star formation and active galactic nuclei that may have an impact on the formation of the galactic disks and their properties. Therefore, exploring the kinematical properties of galaxies is fundamental to understanding what are the main processes that play a crucial role in the galaxy's growth over cosmic time. Thanks to the high angular resolution observations obtained with ALMA, we can finally investigate the kinematics of gas in distant galaxies. Here I present a kinematic study of 20 main-sequence star-forming galaxies at z>5, which represent the bulk of the galaxy population in the first Gyrs of the Universe. Based on the analysis of [CII]158um and [OIII]88um observations, which map cold and warm gas respectively, I discuss the dynamical state of high-z galaxies and show that the ratio between the rotational velocity and velocity dispersion of gas is higher than expected. The high-z galaxy population observed with ALMA is consistent, within the error, with rotating but turbulent disks. The inferred velocity dispersion is systematically 4-5 times higher than what is measured in both the local galaxy population and z=4-5 massive dust-obscured galaxies reported in the literature. The tension between our results and those reported at similar redshift can be ascribed to the systematic difference in galaxy properties between the two samples: the disks of massive dusty galaxies are dynamically colder than that of dust-poor galaxies.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **56** Type: **not specified**

Luca Di Mascolo - Detection of forming intracluster gas in a galaxy protocluster at z~2.16

Wednesday, 14 June 2023 16:50 (20 minutes)

Until now, direct observations of the intracluster medium (ICM) have been limited only to mature clusters in the latter three-quarters of the history of the Universe, and we have been lacking a direct view of the hot, thermalised cluster atmosphere beyond z~2, the epoch when the first massive clusters formed. Probing the thermal evolution of cosmic structures through z~2 —the epoch when intracluster gas starts to assemble and virialise, and cosmic star formation and the activity of active galactic nuclei (AGN) manifest a concurrent peak —is however crucial for exploring the link between galaxy clusters and their over-dense progenitors, as well as finding the observational fingerprint of feedback effects that regulate the later coevolution of the galaxy and intracluster/circumgalactic medium ecosystems. In my talk, I will present our recent detection of the thermal Sunyaev-Zeldovich (SZ) effect in the direction of the protocluster complex surrounding the famous Spiderweb Galaxy (z~2.16), made possible only thanks to the superior capabilities of the Atacama Large Millimeter/Submillimeter Array (ALMA). Such identification of a nascent intracluster halo represents the unambiguous proof that we are witnessing the transition through which a sparse overdensity of galaxies turns into a massive galaxy cluster, providing a statistically meaningful confirmation of long-standing predictions from cosmological simulations, and cluster and galaxy evolution models.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **57** Type: **not specified**

Giovanni Gandolfi - At the frontiers of cosmic history: How ALMA and JWST Team Up to Confirm High-Redshift Galaxy Candidates

Wednesday, 14 June 2023 17:10 (20 minutes)

JWST's ability to observe in the infrared range has pushed the limit of galaxy redshift to greater than 10. The first data release has led to the discovery of over a hundred candidate galaxies at z > 11. Some of these candidates have been identified as being heavily extinguished and feature mature stellar populations; whereas other candidates, dubbed "blue monsters", are bright and dust-free objects characterized by blue UV slopes, challenging the current theoretical models. However, some of these candidates may also be low-redshift contaminants, making it crucial to confirm their nature. After a state-of-the-art review of these JWST high-redshift galaxies candidates, I will showcase how multi-band ALMA follow-up observations can provide essential insights into the nature, physical properties, and redshift of such objects. ALMA, with its precise measurements, high resolution, and sensitivity, operating at millimetre and submillimeter wavelengths, is an essential instrument for confirming the redshift and physical properties of these JWST high-z galaxy candidates. Ultimately, I will show how the synergy between ALMA and JWST has the potential to lead to groundbreaking discoveries on the early Universe.

Session Classification: Cosmology, high-z Universe, galaxy clusters

Contribution ID: **58** Type: **not specified**

Discussion on ”user needs and requests” led by Rosita Paladino and Elisabetta Liuzzo

Wednesday, 14 June 2023 17:30 (30 minutes)

Contribution ID: **59** Type: **not specified**

Andrea Lapi - GalaPy, the highly optimised C++/Python spectral modelling tool for galaxies

Wednesday, 14 June 2023 14:00 (20 minutes)

A key issue in galaxy formation and evolution is to deepen our understanding of the complex (astro)physical processes that govern the properties of galaxies on different spatial and time scales. One powerful method for achieving this task is to model the spectral energy distribution (SED) observed from galaxies at different stages of their evolution along cosmic history. To this purpose, we have developed GalaPy, a new library for modelling and fitting galactic SEDs from the X-ray to the radio band, as well as the evolution of their components and dust attenuation/reradiation. On the physical side, GalaPy incorporates both empirical and physically-motivated star formation histories, state-of-the-art single stellar population synthesis libraries, a two-component dust model for extinction, an age-dependent energy conservation algorithm to compute dust reradiation, and additional sources of stellar continuum such as synchrotron, nebular/free-free and X-ray emission from low and high mass binary stars. On the computational side, GalaPy implements a hybrid approach that combines the high performance of C++ with the user-friendly flexibility of Python, and exploits an object-oriented design via new-generation programming techniques. GalaPy is the fastest SED generation tool of its kind, with a peak performance of almost 1000 SEDs per second. It exploits fully Bayesian parameter space sampling, which allows for the inference of parameter posteriors and thus facilitates the study of the correlations between the free parameters and the other physical quantities that can be derived from modelling. The API and functions of GalaPy are under continuous development, with planned extensions in the near future. In this talk, I will introduce the project and showcase the photometric SED fitting tools that are already available to users, with particular focus on the performance on local and high-z dusty star-forming galaxies featuring prominent emission in the mm band.

Contribution ID: **60** Type: **not specified**

Marcella Massardi - The ALMA Science Archive development and the ARI-L project

Monday, 12 June 2023 17:30 (20 minutes)

In the ALMA 2030 development roadmap a crucial role is assigned to the evolution of the ALMA Science Archive to improve the user experience and maximize the scientific exploitation of ALMA data. To date, the Archive accounts for 10 cycles of data summing up to 1.4 PB of raw data and images representative of the data content that cover all the possible science categories from solar observations to cosmology. Most of the data are still unpublished: the ALMA Science Archive is a gold mine for archival users! The expected telescope upgrade will costitute a huge challenge in the archival data management. In view of the next decade telescope development, several upgrades have already been applied to improve the Archive features and offer easy access and experience to the miners. In this talk I will present some of the already available features and examples of their application to science cases. In particular, I will focus on the results of the Additional Representative Images for Legacy (ARI-L) project that has been a European Development project for ALMA Upgrade leaded by the Italian node of the EU ARC. It increased the legacy value of the ALMA Science Archive by bringing the reduction level of ALMA data from Cycles 2-4 close to that of data from more recent Cycles processed for imaging with the ALMA Pipeline. The project produced, assessed the quality of, and delivered to the ALMA Science Archive more than 300000 images for more than 88.5% of the observational datasets from Cycles 2 to 4 processable with the ALMA Pipeline that were missing pipeline-generated images. ARI-L products are certified for quality and can be downloaded from the ALMA Science Archive as “external products”. The ARI-L project documentation and website are publicly available through the ALMA science portal (https://almascience.org/alma-data/aril).

Contribution ID: **61** Type: **not specified**

Andrea Possenti - Neutron stars pulsating in the mm-band: Italian perspectives (Invited)

Tuesday, 13 June 2023 11:30 (25 minutes)

The pulsed radio emission from the neutron stars has usually a steep spectrum, thus making difficult their investigation in the mm band. However, the availability of new instrumentation is opening new perspectives in the field, hopefully allowing us to address some long standing and still unanswered questions in the field of the emission processes from a neutron star magnetosphere. In particular, the presentation will focus on the expectations arising from the installation of a suite of high frequency receivers at the Sardinia Radio Telescope.

Contribution ID: **62** Type: **not specified**

Cleo Whitcombe - Millimetre-wave spectroscopy of pyrrole: a model for astrophysical searches

Monday, 12 June 2023 15:35 (1 minute)

Pyrrole (c-C4H4NH) is a five-membered heterocyclic ring with C2v point group symmetry. The microwave and millimetre wave spectra of pyrrole and its isotopologues have been investigated since 1952, however, to improve the model's accuracy, we propose the laboratory search within the 60-78 GHz region in which no experimental data is available at present. The free-jet absorption millimetre wave spectrometer allowed us to measure 29 transition lines and a unique global fitting has been generated for the parent species in the ground state. From this, updated spectroscopic parameters have been obtained. Moreover, we measured new transition lines for the 13C isotopologues and the first excited state of the NH wagging motion. We aim to use the predictions to analyse radio astronomical surveys from the ALMA Archive. It is worth noting that other cyclic molecules have been identified since 2018 within the Taurus Molecular Cloud using single dish surveys. For example, a series of cyclic molecules have been detected such as benzonitrile (c-C6H5CN) [McGuire 2018], 1-cyanocyclopentadiene [McCarthy 2021] and 2-cyanocyclopentadiene [Lee 2021], which are possible due to the high electric dipole moment, μ>4 D, authorised by the cyano group. However, aromatic ring compounds with lower electric dipole moments, μ<1 D, have also been observed such as indene [Burkhardt 2021] and cyclopentadiene (c-C5H6) [Cernicharo 2021]. Unfortunately, recent searches of pyrrole in TMC1 were unsuccessful and fixed the column density upper limit to 13.43 cm-2 [Barnum 2022]. Barnum T.J. et al., ACS Earth Space Chem. 5 (2022) 2986. Burkhardt A.M. et al., Astrophys. J. Lett. 913 (2021) L18. Cernicharo J. et al., Astron. Astrophys. 649 (2021) L15. Lee K.L.K. et al., Astrophys. J. Lett. 910 (2021) L2. McCarthy M.C. et al., Nature Astronomy 5 (2021) 176. McGuire B.A. et al., Science 359 (2018) 202

Session Classification: Posters: 1-minute talks

Contribution ID: **63** Type: **not specified**

Eleonora Torresi - Cold molecular gas and nuclear activity in radio galaxies: Linking properties on macro and micro scales

Monday, 12 June 2023 15:30 (1 minute)

Cross-population radio galaxies (FRII-LERG, i.e., powerful radio sources with an inefficient engine) are a powerful tool to investigate the long-standing relation between accretion and ejection. Indeed, they break the classical one-to-one correspondence between accretion mode and radio morphology by separating the effects of optical and radio classifications. To shed light on the nature of FRII-LERG, we present a comparative study of the X-ray and CO properties of a sample of nearly a hundred sources classified in the radio (FRI/FRII) and optical (HERG/LERG) bands. X-rays probe the AGN's innermost regions (sub-pc scale) and allow us to estimate the accretion rate free from contamination effects accurately. CO emission lines represent the best tracer of the molecular ISM, considered a fuel for AGN activity. This systematic and uniform study will help us verify if FRII-LERG are evolved sources, i.e., they now miss the cold fueling material that made them shine in the past

Session Classification: Posters: 1-minute talks

Contribution ID: **64** Type: **not specified**

Wentao Song - Rotational spectroscopic study of cysteamine

Monday, 12 June 2023 15:36 (1 minute)

Cysteamine (NH2CH2CH2SH) is a molecule that is potentially of interest to astrobiology, but it has not yet been detected in the interstellar medium. Its rotational spectrum was investigated in the 18-40 GHz frequency region and two conformers and their vibrational satellites were characterized [1], but the sparse frequency coverage prevents their accurate predictions in higher frequency ranges. We have calculated the conformational potential energy scans at the B3LYP-GD3(BJ)/def2-TZVP level which suggest the existence of more stable conformers. To fill the lack of its spectroscopic knowledge, we have investigated the pure rotational spectrum of cysteamine by means of a Pulsed Jet Fourier transform microwave spectrometer and a Stark modulated free-jet millimeter-wave absorption spectrometer with frequency ranges of 6.5-18 GHz (46.12-16.66 mm) and 59.6-110.0 GHz (5.03-2.72 mm), respectively. According to theoretical predictions, five conformers, belonging to the gauche skeletal arrangement (∠NCCS≈60◦) have been observed, and for three of them also the 34S isotopologues were observed in natural abundance. Some of the detected lines shown a hyperfine structure (Δν ≤ 1 MHz) due to the nuclear quadrupole interaction of the 14N atom. Altogether, 336 transition lines of the five parent species and 63 lines of the three 34S isotopologues conformers were assigned to fit the rotational constants, quartic centrifugal distortion constants and the 14N nuclear quadrupole coupling constants. New laboratory data on cysteamine provided very precise values of the spectroscopic constants that can be used to search for cysteamine in astronomical surveys. Based on the predicted spectra, a search of the different conformers of cysteamine was performed toward the G+0.693-0.027 molecular cloud, where its O-bearing analog (ethanolamine) was detected. The search was unfruitful, and no transitions of cysteamine were found. We computed the upper limit of the ratio of ethanolamine to cysteamine, which is >0.8−5.3, in agreement with the OH/SH ratios found previously in other molecules [2]. References [1] Nandi, R. N., Boland, M. F., & Harmony, M. D. (1982). Microwave spectral studies of rotational isomerism in substituted ethanethiols: 2-Aminoethanethiol and 2-chloroethanethiol. Journal of Molecular Spectroscopy, 92(2), 419-430. [2] Rodríguez-Almeida, L. F., Jiménez-Serra, I., Rivilla, V. M., Martín-Pintado, J., Zeng, S., Tercero, B., Vicente, P., Colzi, L., Rico-Villas, F., & Requena-Torres, M. A. (2021). Thiols in the Interstellar Medium: First Detection of HC(O)SH and Confirmation of C2H5SH. The Astrophysical Journal Letters, 912(1), L11.

Session Classification: Posters: 1-minute talks

Contribution ID: **65** Type: **not specified**

Elena Redaelli - The core population and kinematics of a massive clump: an ALMA view of AG14.49

Monday, 12 June 2023 15:31 (1 minute)

High-mass stars dominate the kinematics and energetics of the interstellar medium, and yet their initial stages are poorly known. In fact, high-mass stars are born in crowded, dense, and distant environments (infrared dark clouds) that pose significant observational challenges. In this work, we use a combination of several ALMA datasets to investigate the properties of the high-mass clump AG14.49, focusing on two aspects: the prestellar core population embedded in it and the clump-scale kinematics. By applying a dendrogram analysis to ALMA Band 7 data of oH2D+, we find 22 cores that are essentially low-mass and subvirial. Using Band 3 data of N2H+ (1-0) combined with a friend-of-friends algorithm to perform hierarchical clustering, we are able to dissect the complex 3D structure of this massive clump and to link kinematically the cores to their parental gas.

Session Classification: Posters: 1-minute talks

Contribution ID: **66** Type: **not specified**

Farideh S. Tabatabaei - Unveiling the interplay between magnetic fields and accretion in a young protocluster

Monday, 12 June 2023 15:32 (1 minute)

The Pipe Nebula and Barnard 59 The Pipe Nebula is one of the closest known star-forming regions, with a distance of d = 163 pc (Dzib et al. 2018). The Pipe cloud has a very low rate of star formation. Indeed, only one active star-forming clump, Barnard 59 (B59), has been found in the cloud (Brooke et al. 2007; Forbrich et al. 2009, 2010). Alves et al. (2008) and Franco et al. (2010) suggested that the fact that only B59 has been active in star formation might be linked to the different magnetic properties of the Pipe. Studies of the morphology of the magnetic field with optical polarimetric observation showed that the filamentary structure is threaded by a magnetic field, which is aligned perpendicular to the cloud's axis, possibly preventing or delaying its global collapse.Magnetic field lines can be bent by gravitational pull and/or infalling material toward the core. In fact, the magnetic field lines in the filament located to the east of the core appear to show a sudden bent in their direction (from parallel to the filament spine to perpendicular to it) as they approach the main core.Our goal is to comprehensively understand the kinematics in the filament located east of the core in B59 and investigate its connection with magnetic field morphology. With the combined analysis of molecular line (13CO, C18O, 12CO all in (3-2)) data from JCMT and polarization data from Pico dos Dias Observatory we obtain a comprehensive understanding of the B59 cloud dynamical evolution.

Session Classification: Posters: 1-minute talks

Contribution ID: **67** Type: **not specified**

Alice Nucara - The Rosetta-Stone project: a comparison between observations and simulations to investigate the star-formation mechanism in massive regions

Monday, 12 June 2023 15:37 (1 minute)

In the context of star-formation the Rosetta-Stone project aims to investigate the star-forming mechanisms governing a sample of massive clumps. To reach our goal we focus on the properties of a sample of 13 sources at various evolutionary stages selected from the SQUALO project, an ALMA 1.3 mm survey. The physical properties of the fragments identified in these images such as their number, mass, and relative distance will be interpreted thanks to the comparison with a statistically significant set of 24 radiative magnetohydrodynamics simulations analyzed at different time-steps and at different projections in the sky (increasing significantly the number of realizations used for the comparison). We explore different realizations of a set of parameters, some of which are known from the observed clump properties (such as clump mass and radius), and some not accessible from the available data (such as the clump initial Mach number or the flux to mass ratio). Each simulation is postprocessed to reproduce the typical features of the SQUALO observations done with ALMA, including realistic sources of noise. The comparison between real data and these sets of simulations will uniquely define on a statistical basis which are the most relevant factors that determine the fragmentation properties observed in massive clumps.

Session Classification: Posters: 1-minute talks

Contribution ID: **68** Type: **not specified**

Andrea Maggio - Free jet millimeter wave torsion-rotation spectrum of a silicon containing molecule: dimethylsylane

Monday, 12 June 2023 15:38 (1 minute)

In the interstellar and circumstellar medium, Silicon can be found in form of silicates in the core of dust grains surroaunding carbon stars; when the grains are destroyed it quickly reacts to form SiO and SiS. As today, among the 260 and more molecular species found in the interstellar medium, less than fifteen are silicon-based, so the research of molecules containing Silicon is crucial to build better theoretical models about formation and reaction pathways. The research and identification of molecular species in the interstellar medium relies heavily on spectroscopic techniques, such as microwave spectroscopy, due to the fact that the rotational spectrum of a molecule can be regarded as its fingerprint and allows a straitgthforward and unambigous determination. For this reason, laboratory work is essential to outline a reliable predictive model useful to analyze cosmological surveys. Being methylsilane among the silicon-based molecules already discovered, we decided to characterize by means of rotational spectroscopy its superior homologue, dimethylsilane, in the hope that it could be found in environments resembling those where most of the silicon-containing species have been found. (cit) In our laboratory we measured the spectra of dimethysilane and its isotopologues in the frequency interval 60 to78 GHz with the supersonic expansion technique, assigning the transistions belonging to four isotopologues of dimethylsilane: those containing the isotopes 28Si, 29Si, 30Si and 13C. Dimethylsilane exhibits internal rotation of the two methyl groups around their own axes. This, has the effect of splitting every rotational transistions into four components with different intensity, labelled AA, EE, EA and AE according to the syimmetry of the torsional wavefunctions. At the conclusion of the experiment, we successfully characterized the spectra of the four species in exam, obtaining their spectroscopical parameters, conducted a geometry analysis and built a predictive model, comprehensive of the internal rotation splitting, useful for the research of these molecuole in the interstellar medium in different conditions. Discovery of methyl silane and confirmation of silyl cyanide in IRC +10216 J.

Session Classification: Posters: 1-minute talks

Contribution ID: **69** Type: **not specified**

Fabrizio Gentile - Radio-Selected NIR-Dark galaxies: the ALMA view behind the dust

Monday, 12 June 2023 15:34 (1 minute)

Since the first (sub)mm observations, it has been clear that the cosmic census of high-z galaxies based on deep optical/NIR surveys is far from complete. The ”darkest galaxies”, in which significant amounts of dust absorb the stellar emission, are in fact missed by these surveys, even though their contribution to the cosmic Star Formation Rate Density and to the evolution of massive galaxies is thought to be significantly high. Due to their elusive nature - however - most of the studies regarding these extremely obscured sources still rely on low statistics and are potentially biased by cosmic variance. In this talk, I will illustrate the potentialities of a radio selection, paired to the lack of a NIR counterpart, to assemble the largest homogeneous sample of ”dark”star-forming galaxies currently known. I will present the Radio-Selected NIR-Dark galaxies collected in the COSMOS field, their properties estimated through SED-fitting and their likely evolutionary path (Gentile 2023a, subm.). Finally, I will discuss our first results on these sources obtained through a new series of ALMA observations and the future perspectives of this project (Gentile 2023b, in prep.).

Session Classification: Posters: 1-minute talks

Contribution ID: **70** Type: **not specified**

Vincenzo Galluzzi - A multi-frequency polarimetric study of the Radio Galaxy ”Pictor A”

Monday, 12 June 2023 15:33 (1 minute)

Pictor A is one of the brightest and most extended radio sources of the Southern Hemisphere. Its distinctive FRII morphology is characterized by two hotspot complexes, each at the edge of a diffuse and roundish lobe: the Western one, i.e. the brightest, shows a more standard morphology, dominated by a compact feature preceded by a filamentary structure orthogonal to the jet direction, while the Eastern one displays a double-structure whose origin is still currently debated, despite this object has been extensively observed from 80 MHz up to 300 GeV (but not at frequencies above 10 GHz). Both regions can be easily resolved by current facilities up to X-rays, hence offering a unique opportunity to characterize and understand the physics of hotspots. Moreover, the Western hotspot arose as one of the best candidates for calibrating and validating polarimetry of high frequency (> 10 GHz) CMB observations, a necessary step for pursuing precision cosmological studies. Thus, we observed with the Australia Compact Array a 7 mm mosaic of the whole radio galaxy, providing high-fidelity polarimetric maps for hotspots and core regions (sampling spatial scales up to ~1 arcmin). We complement our study with recent lower frequency observations from SKA precursors and pathfinders, such as ASKAP and MeerKAT, as well as past GMRT archival data. At the higher frequency, instead, we concentrate on the core, exploiting nearly a decade of ALMA (Band 3,6, and 7) calibrator observations acquired on an almost regular (typically 3-7 days) basis.

Session Classification: Posters: 1-minute talks

Contribution ID: **72** Type: **not specified**

Alice Somigliana - A way to disentangle between viscous and MHD evolution in protoplanetary discs

Monday, 12 June 2023 15:40 (1 minute)

The gaseous component of protoplanetary discs has traditionally been described as undergoing viscous accretion; this picture, however, is being challenged by the observational evidence of levels of turbulence in discs too low to account for the observed evolution. The alternative scenario of MHD disc winds is being explored as potentially able to reproduce the same observed evolutionary features that up to now have been explained with viscosity. Although the two models do lead to different disc properties, to this day none of them has proven to be observationally testable –mainly due to instrumental limitations. Thus, we cannot rule out one or the other model yet, as much as the possibility of both being at play at the same time. In this work, I search for distinctive predictions for the two models that not only we can appreciate from the theoretical point of view, but we can also recognize in the observations. I do so by means of analytical calculations and numerical simulations, performed with my population synthesis code Diskpop. I explore the possibility that signatures of the ongoing evolutionary mechanism may be enclosed in the observed evolution of the correlations between (i) the disc properties and the stellar mass, and (ii) the disc mass and the accretion rate. I find that, while both are theoretically expected to show characteristics peculiar of the considered model, the first does not lead to appreciable differences once convoluted with the observational uncertainties. Conversely, the spread around the disc mass –accretion rate correlation does maintain a distinctive evolution in the two scenarios: I therefore suggest this possible method to disentangle between viscous and MHD theories, laying the ground for future ad-hoc observational surveys.

Session Classification: Posters: 1-minute talks

Contribution ID: **73** Type: **not specified**

Meriem Behiri - Discovering unexplored SHORES of the radio Universe

Monday, 12 June 2023 15:39 (1 minute)

The Serendipitous H-ATLAS-field Observations of Radio Extragalactic Sorces (SHORES, PI: Massardi) is a 2GHz survey recently completed with ATCA for 30 fields (for a total coverage of 15deg2) centered on lensed galaxies in the H-ATLAS SGP region. The fields have been selected to be rich of ancillary data from mm to optical band. Our observations to a sensitivity <150ujy (down to 8ujy in our deep field mapped also at 5, 9 and 20Ghz) allow us to reconstruct properties of star forming galaxies already detected in the submm domain to an unprecedented coverage in spectral bands and including polarization. This will provide a clear overview of the dusty star forming galaxies captured with enough statistics in the various stages of their formation. ALMA archival information are already available for many of the targets improving the sed reconstructions. ALMA follow up are being proposed to build the targets spectral properties, chemistry and relative role of the various emitting components and to characterize in a statistically significant way the fir/radio correlation down to very faint radio galaxy populaions. Finally, we expect to be able to characterize the polarization properties of dusty galaxies that are the major small scales contaminant for cosmological telescopes operating in the mm-submm bands. Therefore, my presentation will show the above mentioned radio-submm synergies that the SHORES survey is exploiting to reach its goals.

Session Classification: Posters: 1-minute talks