CRISOL 25

GALAXY ORIGINS IN THE JWST ERA:

a "crisol" of stars, ISM, and supermassive blackholes in the City of the Three Cultures

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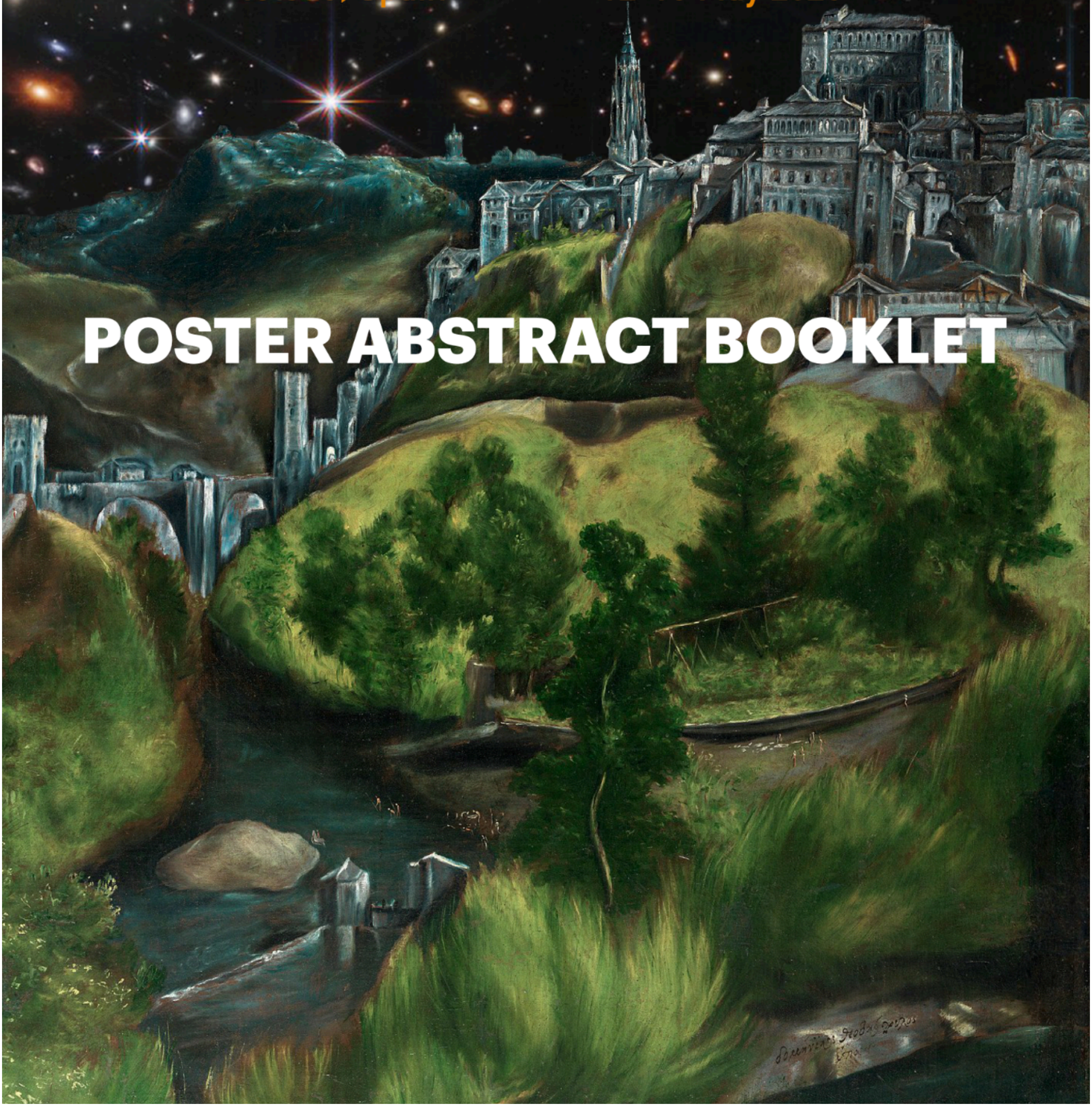
POSTER ABSTRACT BOOKLET



Valentina Abril Melgarejo - Mapping multiphase mixing of metals in Star Forming Galaxies

Metals are fundamental components of galaxy evolution, they regulate the cooling of gas and the transport of momentum, enhancing/quenching star formation. Despite this essential role, we have a poor understanding of how metals are distributed among different gas phases through a galaxy. Chemical inhomogeneities have been detected in the ionized gas of numerous star-forming galaxies (SFGs) via spatially resolved studies, with large implications for the flow of metals within and around galaxies. Recent HR hydrodynamical simulations have opened crucial questions on mixing timescales and the presence of localized enrichment between the two gas phases. In this poster I present the first spatially-resolved multi-phase gas abundance study of a metal poor high-z local analogue, targeting 10 star-forming (SF) regions (ranging between 1 – 15 Myr) with HST-COS and co-spatial optical VLT-MUSE observations. We obtained neutral gas abundances for 13 different ions sampling 8 elements (N, O, S, P, Ni, C, Fe and Si) by analyzing UV spectroscopic data and compared them with the ionized gas abundances (O, N, Fe and S) measured along the same sightlines with the optical IFU data. Determining whether metal abundance offsets exist between the two phases, both globally and locally across a range of HII region properties, enables an exceptionally detailed sampling of chemical mixing scenarios and enrichment mechanisms experienced in SFGs. By exploring metal distribution as a function of age, radius and gas phase, we have pinned down the mixing timescales between the neutral and ionized gas phases. The findings of this remarkable study are applicable to both nearby and high-z SFGs, expanding the potential of multi-phase analysis to the high redshift universe in the era of JWST. As follow-up to this study, spatially resolved analysis in the UV regime is essential to account for the multiple thermal, dynamical and chemical enrichment processes intervening in the evolution of the interstellar medium (ISM). Future UV facilities such as Habitable Worlds (HWO) and UVEX will play a fundamental role in this endeavor.

Daniel Anglés-Alcázar - The role of galactic winds fueling starbursts and quasars in the FIRE cosmological simulations

Central starbursts and Active Galactic Nuclei (AGN) are thought to be fueled by either galaxy interactions or secular processes in gravitationally unstable disks. We use cosmological hydrodynamic simulations from the FIRE project to propose a new nuclear fueling scenario based on the transition that galaxies undergo from bursty to smooth star formation and from prominent global galactic winds to inefficient stellar feedback as they grow above $\log(M_\star/M_\odot)$~10: the last major galactic wind event shuts down star formation, evacuates gas from the inner circumgalactic medium (CGM), and slows down gas accretion onto the galaxy, creating a pileup of gas in the inner CGM which later accretes onto the galaxy achieving a tenfold increase in inflow rate over pre-outflow conditions. We explicitly track the accumulation of gas along the outflow pathway owing to hydrodynamic interactions and we show that ~50% of gas fueling the central ~10–100 pc over the subsequent ~15 Myr has experienced >50% change in radial velocity due to the pileup effect, suggesting that this galactic wind pileup fueling mode may play a crucial role. Galactic winds at earlier times have qualitatively similar effects, but the pileup of gas driven by the last major galactic wind event refuels the galaxy precisely when the deepening stellar potential prevents further gas evacuation by stellar feedback, providing the ideal conditions for quasar fueling at the time when AGN feedback is most needed to regulate central star formation in massive galaxies at their peak of activity.

Lorena Araguete Riesco - Dusty HII regions in NGC628: filling factor and association with PAH content

It remains not well known how the local interstellar medium environment affects the physics of star-forming regions, and whether their precise location might affect the properties of a galaxy as a whole. To this end, we have explored the behavior of the filling factor of HII regions and its relation to other physical-chemical parameters of star-forming regions observable in both at optical and infrared wavelengths. Our analysis uses data of star-forming regions of NGC 628 taken from the SIGNALS survey in conjunction with PHANGS-MUSE data from the same galaxy. After studying hundreds of star-forming regions, we were able to study their electron density up to the low density limit alongside with their size estimation. We have found that those regions with faint star formation activity, characterized by low brightness, high electron density and low filling factors, appear to show a stronger correlation with PAHs emission in relation to their dust content. In contrast, those regions of higher luminosity, and higher filling factors, show a smaller correlation, suggesting the destruction by the hardness of radiation as an acting mechanism in the regions of massive star formation. We propose that these results could be explained within a possible evolutionary scenario.

Leonor Arriscado - Unveiling the correlation between the UV 2175Å bump, PAH emission, and gas-phase metallicity at cosmic noon: a multi-wavelength study with JWST, VLT, and Keck

The UV attenuation bump is one of the most mysterious features of attenuation/extinction curves of galaxies across cosmic time. It is a broad absorption feature centered at 2175Å, and it can be seen in the attenuation curves of some galaxies from z~0 to z~8. Its strongest candidate carriers are PAH molecules, thought to absorb high-energy photons in the UV, resulting in the UV bump, and reemit them in the mid-IR. Recent studies show a relationship between the strength of the bump and stellar mass. This correlation is attributed to the mass-metallicity relationship, as low metallicities result in weaker PAH emission relative to total dust emission due to a lower abundance of PAH molecules.
Here we present the first study of the correlation between the UV bump and gas-phase metallicity, linking its origin with PAH emission at cosmic noon (z~2). Using VLT/MUSE data of 28 galaxies at z~2.1-2.7 tracing the UV 2175Å attenuation bump, we find a

correlation between PAHs, traced by JWST/MIRI, the 2175Å bump, and recent metallicity observations taken with Keck/MOSFIRE. This multi-wavelength study of galaxies at cosmic noon allows us to explore the synergy between JWST and major ground-based observatories, to shed light on the origin of the UV attenuation bump feature, and broadly, the evolution of dust in the early Universe.

Jean-Baptiste Billand - Investigating the growth of Little Red Dot Successors at z<4 with JWST

The James Webb Space Telescope (JWST) has made it possible to discover a very puzzling type of galaxy: a large population of red and compact objects known as "Little Red Dots" (LRDs).
To date, this population remains poorly understood due to its varied features, including a V-shaped spectral energy distribution (SED), broad emission lines, and an extremely compact morphology. Another puzzling phenomenon regarding this population is the significant decline observed in their number density at ($z < 4$). Throughout this work, we investigated their potential successors.
Using NIRCam data in the CEERS field of view, we selected a sample of 100 galaxies that are very similar to LRDs but at lower redshifts. They share common features such as mass, central stellar density, color, number density and compactness. One major difference is that this sample exhibits an outskirt that appears to grow with decreasing redshift, suggesting a possible evolution over cosmic time and that these galaxies may be the elusive descendants of LRDs. A correlation between the growing outskirt and the presence of the V-shape is observed, which could potentially provide insights into the true nature of LRDs and explain their disappearance at low z.

Carmen Blanco Prieto - Unvevealing the spatially resolved ISM in EoR galaxies by combining JWST RIOJA with ALMA

Combining JWST and ALMA observations allows us to investigate the multi-phase structure of high-redshift galaxies. The Reionization and the ISM/Stellar Origins with JWST and ALMA (RIOJA) is a JWST GO Cycle 1 program targeting bright [OIII]88μm emitters at $z > 6$ with NIRCam and NIRSpec IFU to establish the coevolution between the stellar, gaseous, and dusty properties of EoR galaxies.
In this talk we discuss RIOJA's results, focusing on A1689-zD1, a well-known, strongly lensed sub-L* galaxy at $z = 7.13$. It was the first EoR galaxy with dust detection and holds an extensive ALMA dataset. Our analysis combines spatially resolved rest-frame UV/optical NIRCam imaging and optical NIRSpec integral field spectroscopy together with ALMA detections, also spatially resolved, of [CII]158 μm and [OIII]88 μm, along with their underlying dust emissions. This comprehensive dataset reveals the clumpy stellar, gas, and dust structure in A1689-zD1.
The ionized gas clumps display velocity variations of ~100 km/s, suggesting a merging system. The dust and ionized gas clumps coevolve, whereas the stellar emission is offset,

presumably due to dust obscuration. We focus on the spatial characterization of the ISM combining the rest-frame UV/optical and FIR emission lines, deriving properties such as its electron density, temperature and SFR, and find a subsolar metallicity (~0.2Zsun).
These results highlight the power of JWST, together with ALMA, to uncover the coevolution between galaxy components and the role of assembling galaxies in the early Universe.

Elisa Cataldi - Probing the Chemical Evolution of Star-Forming Galaxies at z ~ 2-3: Results from the MARTA Survey

Measuring the abundance of heavy elements in high-redshift galaxies is essential to understanding galaxy formation and evolution. Using data from the MARTA Survey, which includes deep JWST/NIRSpec observations in G140M (~30 hours) and G235M (~7 hours), we have detected faint auroral lines such as [O III]λ4363 and [O II]λ7320/7330 in star-forming galaxies at z ~ 2–3. These detections allowed us to derive direct, temperature-based metallicities, providing some of the first accurate measurements for galaxies during 'Cosmic Noon', the peak epoch of star formation.
I will present a recalibration of strong-line diagnostics, exploring previously uncharted regions of diagnostic space and demonstrating consistency with local relations. We also find a systematic offset in the T2-T3 relation, suggesting different ionization conditions compared to local galaxies.
Additionally, I will discuss the abundance patterns of elements such as Ne, S, N, Ar, and He, offering insights into the characteristics and enrichment history of the ionized gas. Analysis of a galaxy in our sample reveals Wolf-Rayet features, indicative of intense star formation. Preliminary comparisons with multi-cloud photoionization models (Marconi+24) enable us to assess the impact of density inhomogeneities on observed metallicity diagnostics in high-redshift galaxies. These findings refine our understanding of metallicity evolution and ionization conditions, providing valuable constraints for galaxy evolution models.

Matteo Ceci - The JWST/NIRSpec view of the nuclear region in the prototypical merging galaxy NGC 6240

Merger events are thought to be an important phase in the assembly of massive galaxies. At the same time, Active Galactic Nuclei (AGN) play a fundamental role in the evolution of their star formation histories. Both phenomena can be observed at work in NGC6240, a local prototypical merger, classified as an UltraLuminous InfraRed Galaxy (ULIRG) thanks to its elevated infrared luminosity. Interestingly, NGC6240 hosts two AGN separated by 1.5'' (~ 735 pc), detected in both X-ray and radio band.
Thanks to the unprecedented sensitivity and wavelength coverage provided by the Integral Field Unit (IFU) of the NIRSpec instrument onboard JWST, we observed the nuclear region of NGC6240 in a field of view of 1.9x1.9 kpc^2, to investigate gas kinematics and InterStellar Medium (ISM) properties.

We characterized the 2D stellar kinematics. We decoupled the different gas kinematic components through multi-Gaussian fitting and studied the excitation properties of the ISM from NIR diagnostic diagrams. We isolated the ionization cones of the two nuclei, and detected coronal lines emission from both of them. Using H_2 line ratios, we found that the molecular hydrogen gas is excited mostly by thermal processes. We revealed the complex structure of the molecular gas and found a blueshifted outflow near the Southern nucleus, together with filaments connecting a highly redshifted H_2 cloud with the two nuclei. We speculate on the possible nature of this H_2 cloud and propose two possible scenarios: either outflowing gas, or a tidal cloud falling onto the nuclei.

Avinanda Chakraborty - ERIS observations of the baryon cycle in a Cosmic Noon galaxy

Cosmic Noon (z~2) marked a period of vigorous star formation for most galaxies. To shed light on how the baryon cycle drives disc assembly and bulge growth we are using the ERIS integral field spectrograph (IFS) to obtain high spatial and spectral resolution maps of key rest-frame optical lines (OIII]5007, Hβ, Hα, [NII]) in z~2 massive star-forming galaxies. These efficient adaptive optics-corrected observations rival JWST in terms of spatial and spectral resolution. Here I will present preliminary results from ZC406690 (z=2.2 and,log(M_star) ~10.6). The galaxy shows a prominent clumpy ring like structure. In some of these clumps we detect an asymmetric line profiles for [OIII]5007 which can be due to powerful feedback and that hints towards intense star formation in the clumps. With our initial results we spatially resolve the extent of the outflows in clumps and study the conditions of the ionised gas in clumps via several diagnostic line ratios. I will conclude by putting these observation within the larger context of the study of star forming clumps and star-formation driven feedback at Cosmic Noon.

Nuo Chen - Compact [OIII] emission-line regions ("Green Seeds") in Hα emitters at Cosmic Noon from JWST Observations

We present a rest-frame optical, spatially resolved analysis of more than 100 Ha emitters (HAEs) at z ~ 2.2 in the ZFOURGE-CDFS field using NIRCam imaging from the JWST-JADES. The ultra-deep, high-resolution data gives us maps of the resolved emission line regions of HAEs with stellar mass ranging from 10^8 M_sol to 10^10 M_sol . An [OIII] emission line map of each HAE is created from the flux excess in F150W, leading to the discovery of kiloparsec-scale compact emission line regions ("Green Seeds") with high equivalent widths (EW). We obtain a sample of 128 Green Seeds from 68 HAEs with rest-frame EW [OIII] > 200A. Moreover, 17 of them have extremely large EW [OIII] > 1000A, suggesting the possible Lyman continuum (LyC) leakage from these emission line regions. Embedded within the host galaxy, many Green Seeds correspond to UV star-forming clumps and HII regions, indicating elevated starburst activity in them, with specific star formation rates (sSFR) several times higher than that of the host galaxy. Based on theoretical frameworks, Green Seeds are expected to be formed through gravitational disk instability and/or galaxy mergers. Considering the stellar masses of Green Seeds, we speculate that high-mass Green Seeds may migrate toward the galactic center to build the central bulge, while low-mass Green Seeds are easily disrupted and short-lived. Besides, we propose that some Green Seeds could be the progenitors of globular clusters or ultracompact dwarf galaxies observed in the local universe.

Michele Costa - Tales of Dust: a direct constraint of dust temperature in the most distant quasars known

Observations of luminous quasars at z>6 in the FIR regime provide a glimpse into the early stages of galaxy-SMBH coevolution during the first billion years of the Universe. These exceptionally bright sources are hosted in galaxies experiencing intense bursts of star formation, making them strong candidates for precursors of today's massive elliptical galaxies. However, studying the host galaxies at such high redshifts is challenging, even though ALMA/NOEMA observations have proven highly effective in probing the physics of their ISM. Specifically, observing the MBB (modified black-body) dust continuum emission can help estimate fundamental parameters like infrared luminosity and SFR.
Unfortunately, the dust SED of these sources has been reliably constrained in only a handful of objects, due to the lack of observations probing the 80-micron regime, where the dust MBB is expected to peak.
In this work, I present a sample of 11 sources for which we obtained ALMA ACA Band 8 observations, enabling us to fully constrain their IR emission and directly investigate dust physical properties. Dust temperature plays a crucial role in this analysis, as recent studies suggest its evolution with redshift can serve as a proxy for increased star formation efficiency in high-redshift galaxies. However, the behavior of this trend at cosmic dawn has remained a topic of debate until now. I will here illustrate our findings and discuss how the presence of a bright AGN may influence the results, particularly if the large values of temperature we derive could be due to this unresolved contribution.

Alejandro Guzmán Ortega - Dust-aware synthetic observations of high-redshift JWST galaxies in TNG50: the impact of modeling assumptions and comparison to deep galaxy surveys

In recent years, forward-modelling of hydrodynamical cosmological simulations has become a powerful tool for interpreting observational data, validating galaxy formation models, and making predictions for upcoming surveys. In particular, using spectral energy distribution (SED) fitting, one can infer various properties of simulated galaxies in an observationally motivated fashion, including stellar mass, star formation rate, and dust content. However, this technique relies on several assumptions about the underlying astrophysical processes, such as star formation histories and dust attenuation laws. These modelling assumptions can be a major source of uncertainty in the inferred parameters, complicating the interpretation of results. In this study, we leverage the TNG50 cosmological simulation, in combination with the SKIRT radiative transfer code, to explore how varying assumptions in SED fitting affect the recovery of physical properties for high-redshift ($z \gtrsim 3$) galaxies. By applying traditional SED fitting methods to synthetic observations, we systematically test the impact of different modelling choices, such as dust attenuation models and star formation histories, on the derived galaxy parameters. This work aims to provide a clearer picture on the extent to which modelling assumptions can affect the interpretation of data from current and upcoming deep galaxy surveys.

Patricia Iglesias Navarro - Simulation-based inference of galaxy properties per pixel with JWST

The spectral energy distributions (SEDs) of galaxies provide detailed insights into their stellar populations, capturing key physical properties such as stellar mass, star formation rate (SFR), age, metallicity, and dust attenuation. However, this is an inversion problem that is highly degenerate, especially when working with integrated observations and a limited number of photometric bands. We introduce an efficient Bayesian SED fitting framework tailored to multiwavelength pixel photometry from the JWST Advanced Deep Extragalactic Survey (JADES). We base our method on simulation-based inference using normalizing flows (NFs) to achieve rapid posterior inference across galaxy pixels. We exploit the unprecedented spatial resolution, wide wavelength coverage, and depth provided by the Hubble Space Telescope (HST) and the James Webb Space Telescope (JWST). Our method is trained using simulated photometry generated from the MILES stellar population models, with both parametric and non-parametric star formation histories, realistic noise, and filter sensitivity thresholds emulating ACS and NIRCam observations. We validate this amortized, simulation-based inference on mock datasets. The resulting posterior distributions for stellar population properties are robust and well-calibrated, with a high R^2 score of 0.99 for the stellar mass and an inference speed of 10^{-4} seconds per pixel. We apply this pipeline to JADES observations to produce spatially resolved maps of galaxy properties, down to $S/N=5$ per pixel, averaged over the F277W, F356W, and F444W filters. We present six example galaxies with $0.6\leq z \leq 5.6$, and statistically analyse ~ 1000 JADES galaxies with spectroscopic redshifts to study the outshining effect in stellar mass estimations for the different SFH priors. By accelerating pixel-based Bayesian inference, our model provides a scalable solution for extracting high-fidelity stellar population properties from HST+JWST datasets, opening the way for statistical studies of galaxy evolution at sub-galactic scales.

Jean-Baptiste Jolly - Dust mass measurements as a function of redshift, stellar-mass and star formation rate, from z = 1 to z = 5 in the ALMA Lensing Cluster Survey

Understanding the dust content of galaxies and its evolution is fundamental for our understanding of galaxy evolution. Dust acts as both a catalyst of star formation and as a shield for star light. State-of-the-art millimeter facilities like ALMA have made dust observation ever more accessible, even at high redshift. However dust emission is typically very faint, making the use of stacking techniques instrumental in the study of dust in statistically sound samples.

Using the ALMA Lensing Cluster Survey (ALCS) wide-area band-6 continuum dataset ($\sim$110 arcmin^2 across 33 lensing clusters), we aimed at constraining the dust mass

evolution with redshift, and its scaling relation with stellar mass and star formation rate (SFR).
After binning sources according to redshift, SFR and stellar mass we performed a set of continuum stacking analyses using LineStacker on sources between z = 1 and z = 5, further improving the depth of our data. The large field of view provided by the ALCS allows us to reach a final sample of ~ 4000 galaxies with known coordinates and SED-derived physical parameters. Through stacking we retrieve the continuum 1.2 mm flux, a known dust mass tracer, allowing us to derive the dust mass evolution with redshift and its scaling relation with SFR and stellar mass.
We observe clear continuum detections in the majority of the subsamples. We observe a steady decline in the average dust mass with redshift. Moreover, sources with higher stellar mass or SFR have higher dust mass on average, allowing us to derive scaling relations.

Jessica Kelley-Derzon - Modeling UV Bright Galaxies at High Redshifts with Insights from JWST Observations

One of the most significant discoveries from near infrared observations by the James Webb Space Telescope (JWST) during its first year was the discovery of stunning abundances of ultraviolet-bright galaxies in the ultra-high-redshift (z>7) Universe. Rest-frame UV observations of high-redshift galaxies revealed that the UVLF of galaxies demonstrates nearly no evolution over the redshift range z=8-12. This starkly contrasts the expected fall off of high-mass dark matter halos over this redshift range. Understanding the physical mechanisms allowing for such copious star formation and abundance of UV photons when the abundance of hosting dark matter halos steepens has emerged as a major problem in the field of galaxy evolution. Many (20+) papers have been published this year alone seeking to understand this evolution by exploring isolated physical effects, such as variations in dust properties, star formation burstiness, top-heavy initial mass functions (IMF), nebular line emission and many others. No comprehensive models currently exist that include and assess the impacts of all of these potential physical drivers of the non-evolving UVLF at high-z. This project employs a novel cosmological simulation, the AREPO Smuggle model, coupled with a novel form of stellar feedback, evolving dust, and radiative transfer to test multiple physical properties and discern potentially degenerate solutions. I will present results from these simulations to demonstrate the impact of a diverse range of putative physical mechanisms driving the unvarying trend of the high-z UVLF within a single, cohesive numerical model.

Mahsa Kohandel - Synthetic Clones of the Most Distant Galaxies in the Universe

JADES-GS-z14-0 (z = 14.32) and GHZ2 (z = 12.34) are the only galaxies at z > 10 with synergetic JWST-ALMA observations, offering an unprecedented opportunity to investigate the physical properties of the earliest galaxies. These observations reveal compact morphologies, enriched metallicities ($Z \sim 0.05-0.2Z_\odot$), and far-infrared

emission lines such as \OIII~$88,\mu$m, yet interpreting these systems remains challenging due to the extreme gas dynamics, intense radiation fields, and rapid assembly timescales of the early universe.
In this presentation, I will introduce Amaryllis, a simulated galaxy from the \texttt{SERRA} suite, designed as a synthetic counterpart to these super-early galaxies. Amaryllis reproduces key properties, including emission line luminosities (\CIII~λ1908, \OIII~λ5007, \CII~$158,\mu$m), metallicity gradients, and spatial distributions, while also providing unique insights into its internal structure and ISM conditions. The galaxy exhibits a highly pressurized ISM ($P \sim 10^{7.5} , \rm{K , cm^{-3}}$), a disk-like morphology with spiral arms, and stark suppression of high-ionization emission lines in its dense central regions due to self-shielding and gas pressure effects.
Using Amaryllis, I will present predictions for the detectability of key UV, optical, and FIR features, emphasizing the interplay between metallicity, ISM dynamics, and star formation history. These results provide a pathway to interpret existing JWST-ALMA data and guide future observations aimed at unravelling the nature and evolution of the first galaxies.

Evgenia Koutsoumpou - Cosmic ray feedback on the ionized gas within nearby AGN and star-forming galaxies

Cosmic Rays (CRs) in active galactic nuclei (AGN) are a potential source of feedback able to regulate star formation. These non-thermal particles, accelerated by shocks, penetrate deep into the molecular gas, driving the heating and chemistry of the interstellar medium (ISM), and launching massive outflows. We examine the impact of CR feedback on ionized gas in a sample of nearby AGN and starburst galaxies. Using Cloudy photoionization models, we investigate CR effects on nebular gas, focusing on densities ($1–10^{4}$ cm^{-3}), ionization parameters ($-3.5 \leq \log U \leq -1.5$), and CR ionization rates ($10^{-16}–10^{-12}$ s^{-1}). Our results, compared with VLT/MUSE observations of Centaurus A, NGC 1068, and NGC 253, reveal that high CR rates ($\gtrsim 10^{-13}$ s^{-1}) can alter the thermal structure of ionized gas. Our study unveils that high CR rates, as those expected in AGN and strong starbursts, can induce a secondary ionization layer beyond the photoionization-dominated regions, enhancing the emission of low-excitation transitions such as [N II]λ6584Å, [S II]λλ6716,6731Å, and [O I]λ6300Å. AGN models with CRs reproduce the Seyfert locus in BPT diagrams without super-solar metallicities, contrasting pure photoionization models, whereas star-forming models can explain non-AGN sources in the LINER region. Finally, we suggest new maximum BPT limits to differentiate regions dominated by AGN from star forming areas also impacted by high CR rates. Overall, our findings illuminate how AGN and supernova-produced CRs shape ISM in the local universe.

Ivan Kramarenko - Robust measurements of star formation rates at $3 < z < 5$ in the JWST era

Measuring star formation rates (SFR) of galaxies at different redshifts allows us to trace the galaxy mass build-up across cosmic time. In the early Universe ($z > 3$), SFRs have long been uncertain as the most sensitive SFR measurements relied on the rest-UV continuum emission which is subject to strong dust attenuation. This situation is now changing dramatically thanks to JWST whose impressive near-IR spectroscopic capabilities provide access to rest-optical tracers of star-formation such as H-alpha at $z > 3$ for the first time. Here, I will present the SFR measurements of ~500 H-alpha emitters spanning SFRs of ~0.5-500 Msun/yr at $3 < z < 5$ from JWST NIRCam/grism observations. To minimize uncertainties associated with dust corrections, I will revisit typical assumptions made about the physical properties of dust (including star-dust geometry) by computing the H-alpha radiation transfer in SPHINX, the suite of state-of-the-art cosmological radiation-hydrodynamical simulations. I will then demonstrate how the star-formation rate density inferred from the dust-corrected H-alpha emission compares to the earlier measurements predominantly based on the rest-UV emission, providing a more comprehensive picture of the galaxy mass build-up in the early Universe.

Liu Weizhe - Probing Quasar Feedback via Outflows within the First Gigayear

It remains an open question how luminous quasars in the Epoch of Reionization form and interact with their massive host galaxies. The advent of JWST has opened a new window for direct investigations of such issues with unprecedented details. In this talk, I will present our latest JWST results on the outflows and feedback of high-z quasars. I will start with a NIRSpec integral field spectroscopy study of the fast outflow found in J1007+2115 at $z=7.5$, one of the earliest known in the current universe. This outflow is likely faster than the escape velocity, and its properties follow the trends of other quasar-driven outflows at lower redshifts. The mass and kinetic energy outflow rates suggest that the outflow meets the minimum requirement for negative feedback based on simulation predictions. I will then turn to our ongoing effort to systematically examine the quasar feedback via fast outflows at $z>5$ through JWST spectroscopy of a large sample of quasars. Our results suggest that extremely fast, galaxy-scale, quasar-driven outflows are more prevalent at $z>5$ than at later epochs, with some of them among the most rapid outflows known in the universe so far. These outflows may easily escape their host galaxies and impact the circumgalactic and/or intergalactic medium. They are likely powerful enough to provide significant feedback to their host galaxies within the first gigayear and lead to the quenching of the earliest quiescent galaxies.

Ruari Mackenzie - The Environments of Early Quasars and Proto-Cluster Evolution: Results from the EIGER Survey

NIRCam grism spectroscopy recently lifted the veil on the environments of z>6 quasars, establishing that many of them formed in rich over-dense environments. I will present results from the EIGER survey, over the six fields we have detected ~900 spectroscopically selected [OIII] emitters over 5.3<z<7.0. My analysis attempts to place these environments in cosmological context by matching to large-scale N-body simulations, using a semi-empirical galaxy prescription. My results indicate that the most probable halo mass for a typical quasar host is around 2x10^12 solar masses, while the most massive halos in the simulations are disfavoured. Following the descendants to z=0, I find that these systems are the progenitors of present-day galaxy clusters, typically above 10^14 solar masses. I will also introduce a sample of serendipitous over-densities, selected in public grism surveys (4<z<7), some of which host quenched galaxies and obscured AGN (LRDs). I will compare the higher redshift quasar proto-clusters and the more evolved structures, to understand if these are distinct populations, or simply different phases of cluster formation. These surveys enable us to measure the onset of the suppression of central star formation in early proto-clusters, and explore the connection between LRDs and their environments.

Montserrat Martínez - The role of AGN in quenching Massive galaxies z~3-5, Observational constraints for simulations.

Active galactic nuclei (AGNs) are the main suspects in ceasing the star formation of massive quiescent galaxies. We analyzed a sample of 40 massive galaxies with log(M)>10, between 3<z<6 observed with JWST, to identify the ionization source of the emission lines exhibited in their spectra. We present the BPT+S line ratio diagnostic diagram, a new variation of the BPT diagram capable of disentangling star-forming galaxies and AGNs at 3<z<5 based on photoionization models for star-forming galaxies and AGNs across a wide range of metallicities. We identified 7 AGN candidates in these massive galaxies, with the BPT+S at 3<z<5, with 10<log(M)<11. We calculated their star formation histories (SFHs) with CIGALE, confirming the AGN component in the galaxy sample. To explore the role of AGNs in quenching massive galaxies, we compare our observational sample to TNG300 simulations. The SFHs from CIGALE suggest a peak of star formation at least 1 Gyr earlier than AGNs in TNG300. The merger history of the AGNs in TNG300 shows that only 5% of the AGNs at z=4 end up quenched by z=3, explaining the low number density of massive quiescent galaxies found at z=3 in TNG simulations. The low percentage of AGNs quenching galaxies indicates inefficiency in implementing the feedback mechanism in TNG300, which shifts from thermal to jet mode in AGNs to quench massive galaxies effectively.

J. Miguel Mas Hesse - Single vs. double reionization of the Universe

One of the scenarios predicted by the autoconsistent model of the primordial Universe evolution AMIGA includes a first reionization of the Universe by a redshift z~10, followed by a new neutralization before entering the final reionization process that was completed by z~6. This scenario predicts an increase in the visibility of Lyman alpha emitters at z~10, since the ionized medium would be transparent to Ly alpha photons. The JADES survey has recently discovered a Lyman alpha emitter at z~10.6, with rest EW(Ly alpha) ~18 Å, in an epoch of the Universe where no Ly alpha photons should normally escape. We will discuss in this presentation the implications of this discovery and the consistency with the double reionization scenario predicted by AMIGA, as well as other possible explanations for the visibility of the Ly alpha emission line at this redshift, like the rapid formation of huge ionized expanding bubbles.

Rosa María Mérida - Possible environmental quenching in an interacting LRD pair at z ~ 7

Little Red Dots (LRDs) represent one of the most remarkable discoveries made by the JWST. These red, compact sources show a characteristic "v" shaped spectral energy distribution (SED), consisting of a nearly flat to blue rest-frame ultraviolet (UV) continuum and a very steep slope in the optical. These properties make them a challenge for SED modeling, even with the aid of spectroscopic data. We report the discovery of a z ~ 7 LRD pair just 3.3 kpc apart, along with three satellite galaxies, as part of the Canadian NIRISS Unbiased Cluster Survey (CANUCS). The SEDs of this LRD pair show strong evidence for a Balmer break, consistent with a recent (~100 Myr) quenching of star formation. Their UV excess is consistent with a dust-free AGN, while the optical continuum would be powered by the emission from an obscured post-starburst and the AGN at a subdominant level. In contrast, the satellites are compatible with a recent-onset (~100 Myr), ongoing burst of star formation. The proximity of these galaxies suggests that their interaction may be responsible for their recent star formation histories, which can be interpreted as environmental bursting and quenching in the Epoch of Reionization.

Henrique Miranda - Unveiling an Extreme Emission Line Galaxy at Cosmic Noon with JWST

Studying extreme emission line galaxies (EELGs) is crucial, as they reflect a key phase that most galaxies undergo during their evolution and closely resemble the properties of galaxies in the young universe, providing valuable insights into galaxy formation and evolution. In this talk, we present the analysis of an EELG at z=2.0567, identified using JWST/NIRSpec data from CEERS and multi-wavelength photometry from ground and space-based facilities. With an effective radius of ~2kpc (from HST images), this compact galaxy is low-mass (M_*~10^8 $M_\odot$), young (tL~17Myr), and metal-poor (ZL~0.4$Z_\odot$). Such values, points towards this galaxy being in the assembly phase, similar to high-z counterparts found with JWST. Spectral fitting using FADO reveals a dominant nebular continuum and evidence of a recent starburst, supported by the measured high equivalent widths in [OIII]λ5007, Hβ, and Hα, and elevated star formation rate (SFR~26$M_\odot$/yr). Emission line diagnostics suggest sub-solar gaseous metallicity, negligible dust extinction, and extreme ISM conditions (Te~2×10^4 K, ne~5×10^3 cm^−3). The detection of HeIIλ4686 emission hints at Wolf-Rayet stars, underscoring the presence of hot, massive stars. No evidence of AGN activity is found, and we attribute the observed strong emission lines to star formation. These properties indicate conditions analogous to the earliest galaxies, making this source a valuable laboratory for studying the extreme physical processes occurring within galaxies during the Cosmic Noon, thus contributing to understanding galaxy evolution in the early Universe.

Benjamín Navarrete Rivas - New calibrations for gas-phase chemical abundances of local analogs of high-z galaxies

Performing gas-phase abundance studies has been historically challenging in the early Universe with ground-based telescopes. With JWST, we have been able to use the direct-method up to z=8 and beyond thanks to auroral line detections. Nevertheless, even in the era of space telescopes, not all the lines are accessible and astronomers still rely on temperature relations or metallicity calibrations based on strong emission line ratios to estimate abundances of the gas of high-z galaxies. These relations have been explored in the local Universe, but it is still unclear whether they hold for the ISM in star-forming high-z galaxies where the gas shows harder ionization and different physical conditions than local HII regions. Here we explore such relations using local analogs of galaxies at z ~ 2.3. We assess the validity of temperature relations and metallicity calibrations by comparing against existing literature relations. We found good agreement in the metal-poor regime, but systematically increasing differences for galaxies with 12 + log(O/H) >~ 8.6. We present the new relations and discuss the impact that a misuse of local calibrations could cause in abundance studies at high-z.

Robert Pascalau - Vigorous Stellar Rotation and Low Dark Matter Content in a Massive Compact Quiescent Galaxy at z =4.7

JWST observations have uncovered a large number of massive quiescent galaxies at z > 3, which theoretical simulations struggle to reproduce. Many previous observational studies revealed the rapid star formation histories of such galaxies. However, we have little knowledge of their mass assembly history, which gives essential information about their quenching mechanism. Using stellar kinematics, we can look directly into the processes governing the build up of this kind of galaxies. We present new high-resolution JWST/NIRSpec Integral Field Spectroscopy observations of GS-9209, one of the highest z quiescent systems currently known.
With this extraordinary data, we are able to measure the stellar rotation for the first time at z > 4. With a spin parameter of λ = 0.54, this galaxy challenges the scenario of merger-dominated galaxy growth. It also proves that quenching did not destroy the stellar disc. We use dynamical modelling to determine the Dark Matter fraction and the Black Hole mass in this galaxy, and compare these results to cosmological simulations and to independent observations. We measure only a modest anisotropy deviation from the spherical symmetry. Overall, the dynamical properties of this infant Post Starburst galaxy are widely different from those of Cosmic Noon and more recent Spheroids and Early Type Galaxies.

Kaila Ronayne - MEGA: Spectrophotemetric SED Fitting of Little Red Dots Detected in JWST MIRI

We examine eight spectroscopically confirmed Little Red Dots (LRDs) in the EGS with detections from JWST/MIRI. Using the PROSEPCTOR Bayesian inference framework, we perform spectrophotometric spectral energy distribution (SED) modeling with NIRSpec/Prism, NIRCam, and MIRI observations. We test if the MIRI data suggest a preference for star-formation or AGN-dominated solutions, providing insights into the role of dust in LRDs.

Elka Rusta - Connecting high and low-z: Is JWST Observing the Progenitors of the Milky Way at the Cosmic Dawn?

The recent JWST observation of the z=8.3 Firefly Sparkle offers a unique opportunity to link the high- and the low-z Universe. Indeed, the claim of it being a Milky Way type of assembly at the cosmic dawn allows us to interpret the observation with locally calibrated galaxy-formation models.

Here, we use the MW-evolution model NEFERTITI to perform forward modeling of our Galaxy's progenitors. We build a set of mock spectra for the MW building blocks to make predictions for JWST and to interpret the Firefly Sparkle observation. First, we find that the most massive MW progenitor becomes detectable in a deep survey like JADES from z around 8.2, meaning that we could have already observed MW-analogs that require interpretation. Second, we predict the number of detectable MW progenitors in lensed surveys like CANUCS, and interpret the Firefly Sparkle as a group of MW building blocks. Both the number of detections and the observed NIRCam photometry are consistent with our predictions. By identifying the MW progenitors whose mock photometry best fits the data, we find bursty and extended star-formation histories, and estimate their properties with forward modeling (e.g. halo mass, stellar mass, SFR, gas metallicity).

Uncovering the properties of MW-analogs at cosmic dawn by combining JWST observations and locally-constrained models, will allow us to understand our Galaxy's formation, linking the high- and low-z perspectives.

Francesco Salvestrini - Witnessing the assembly of massive galaxies in the early Universe

The coexistence between the outstanding mass growth of the SMBHs powering luminous quasars at the Epoch of Reionization (EoR, z > 6), and the concurrent growth of their host galaxies. The knowledge of how quasar host build up and evolve has been limited to far-IR/sub-mm observations till recently. Now, thanks to the growing number of JWST detections of stellar light arising from the host galaxy of quasars and luminous AGN, we investigate the cycle of star formation in the brightest objects in the first billion years.

Here, we exploit mm observations of dust and gas on a sample of 25 quasars at the EoR, including all known quasars at z>7.

These highly accreting SMBHs are hosted in galaxies with a copious amount of dust (~10^8 Msun), but relatively low (<~10^10 Msun) gas reservoir. The intense star formation

activity suggests that these galaxies are undergoing a rapid growth, with efficiencies that are among the highest observed so far.
Thanks to JWST/NIRCAM, we now constrain the role of star (10^10 Msun) in the baryonic cycle, which are driving the dust formation, and gravitational collapse of the molecular gas to form new stars.
This is happening at extreme rates, with low gas fractions (~MH2/M*~0.3-0.01), when compared with those measured in star forming galaxies and AGN at later epochs.
This suggest a tight connection between the high star formation efficiency in the host and the bright quasar phase across a wide range of luminosity.

Stefano Sotira - Simulated cold gas formation and AGN activity in galaxy clusters

Supermassive black holes (SMBHs) at the center of brightest cluster galaxies (BCGs) are the most massive black holes in the universe. Understanding their growth via gas accretion and the consequent feedback throughout the cosmic epoch may allow us to constrain the galaxy host and SMBH co-evolution model.
In this work, we simulate the active galactic nuclei (AGN) feedback at the center of the BCG in a cool core cluster to study the cold gas formation due to the cluster cooling flow and the AGN activity that ends in accreting the SMBH and in enhancing the star formation. We use hydrodynamic simulations with the AREPO code and the addition of the GRACKLE tool, which allows us to simulate in detail the cold phases, both warm and molecular, with a cooling function based on the amount of metals and species in the medium. With this setup, we can simulate the self-regulated AGN cycle starting from the cluster cooling flow and considering how different AGN feedback modalities will impact the BCG galactic and circum-galactic medium and, consequently, its star formation.
Determining the AGN activity outcoming cold gas formation due to the jet entrainment and turbulent interactions at the jet edge in a cluster environment, resolving both the warm and molecular gas phases, we can make detailed predictions about the kinematics and the dynamics of these gas phases that are observable with the James Webb Telescope.

Dhruv Zimmerman - How well can we know high-z galaxies? An evaluation with simulated spectra, SED fitting, and machine learning

One of the more intriguing observations from the early Universe by JWST is the inference that UV-bright galaxies have stellar masses near or at the cosmological theoretical limit. One common argument to alleviate this tension is that the stellar outshining problem is exacerbated in the bursty early Universe, biasing the inference of galaxy stellar masses. Potential systematic uncertainties in accurately determining physical properties of high redshift galaxies represent a significant barrier for maximizing the impact of JWST. The goal of this presentation is to quantify the impact of stellar outshining on physical property inference in the early Universe and to develop a new machine learning-based solution to enable observers to more accurately determine the physical properties of the first galaxies. We generate SEDs from numerical experiments with SPS codes with increasingly complex SFHs and from simulated high-z galaxies with the SMUGGLE physics suite in the AREPO hydrodynamics code. Our galaxy formation models include a new implementation of dust physics that results in reasonably accurate rest-frame luminosities from early Universe galaxies and realistic star formation histories produced by bursty feedback. With these mock SEDs, we are then confronted with an inverse problem that can be solved via classical SED fitting techniques or machine learning methods. We present both the theoretical limitations for traditional SED fitting software to derive the physical properties of early Universe galaxies as well as a new machine learning software that can significantly improve the accuracy of inferred stellar masses from high-z JWST observations.