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The S-PLUS Fornax Project (S+FP): Globular clusters in the Fornax Cluster using the S-PLUS data

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Globular Clusters (GCs) are directly correlated to the mass build up of a galaxy. They are related to the halo creation, the formation of the bulge or subsequent encounters. In galaxy clusters, GCs can be also bound to the cluster potential, being stripped from the infalling galaxies. They are therefore vital for studies of cluster environments as well as group pre-processing. We carried out a photometric study of GCs in the Fornax Cluster (FC) using images observed in the 12 photometric bands of S-PLUS corresponding to 106 S-PLUS pointings around NGC 1399. Those pointings cover a sky area of ∼208 sq. deg towards the FC region. Studying the properties of spectroscopically confirmed GCs, we have designed a method to select GC candidates using structural and photometric parameters, as well as SED fitting techniques using the 12-bands.

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The formation of the smallest galaxies

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We establish a new formation scenario for the smallest galaxies in the Universe, the ultra-faint dwarf spheroidal galaxies. In the ΛCDM scenario, those galaxies form first, but their initial stellar distribution is still unknown, as even the most modern cosmological simulations do not have sufficient resolution. We adapt the Dissolving Star Cluster Model scenario and replace the multiple SCs by a single fractal distribution of stars in the centre of the DM halo. This initial fractal distribution is evolving into the luminous component of the dwarfs we see today. If the stars have initially virial equilibrium velocities, the final $r_{1/2}$ of the resulting dwarf galaxy depends only on the scale-length of the DM halo. This behaviour changes if the stars initially have close to zero velocities. We find in our simulations that $r_{1/2}$ is oscillating after many Gyr of evolution. The oscillations are strongest with larger halo scales and larger fractal sizes. The mean size strongly depends on the size of the fractal and no longer on the halo scale-length. The equilibrium models reproduce the size of UMa II using $R_{\rm scale} = 200 - 250$ pc; the 'cold' initial models need $r_{\rm frac} = 250 - 500$ pc.

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Forecasting cosmological constraints from the velocity angular power spectrum of type Ia Supernovae

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The universe's large-scale structure holds significant information about both geometry of spacetime and the growth of cosmic structures. Recent analysis of modern galaxy surveys have demonstrated the effectiveness of combining observables, such as weak lensing and galaxy clustering, in a multi-probe approach as the 3x2pt function to infer cosmology (Prat et al. 2023; Abbott et al. 2022). Complementary information about the growth of structure can be obtained from peculiar velocities, induced by the gravitational attraction of large-scale structures (Quartin et al. 2022). Type Ia supernovae were not commonly used for growth measurements due to the small number of available objects in current surveys. This situation is about to change with future photometric surveys, such as Rubin LSST, which will offer a large and uniform sample of SNIa for use in peculiar velocity studies (Kim & Linder 2019; Howlett et al. 2017). The main goal of this study is to apply the Fisher information methodology to assess the increase in constraining power when combining the angular power spectrum of SNIa peculiar velocities with the standard Rubin LSST observables. We will investigate scenarios with velocities alone, and in combination with galaxy density and gravitational lensing observables (so-called "3x2pt" observables). This is a first step towards future measurements of cosmological parameters using a combination of Type Ia supernova peculiar velocities and 3x2pt cosmological estimators in the context of Rubin LSST.

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Probing black hole formation via collisions in Black Hole Clusters

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The origin of SMBHs in galactic centers at high redshift is still unknown. In recent decades, astronomers have proposed a wide range of models to explain the formation of these objects. Some theoretical explanations include very large seed masses, hyper-Eddington or supra-exponential accretion, the collapse of the first baryon structures, and the formation of SMBHs via BH mergers. In this project, we examine the formation of a massive object in the nuclear star cluster (NSC) core through the fusion of black holes, in a cluster affected by the potential well of gas. We consider the effect of an external gas potential and post-Newtonian corrections in our study. The model is investigated via N-body simulations using the Nbody6++GPU code. We present the results of 100 simulations, where we vary the mass of the gas potential. Since the simulations are computationally expensive when considering the real speed of light, we treat it as a free parameter and determine results assuming different speeds of light, with the aim of extrapolating our results to the physical value. Our findings indicate that the time of core collapse in the presence of a deeper external gas potential tends to decrease in relativistic clusters. For clusters out of the relativistic state, the trend is completely different, tending to increase for higher external potential. On the other hand, the BH seeds that form are set in two ranges: $\approx 10^4 M_\odot$ for clusters in relativistic states, where almost all BH mergers end in the BH seed, and $\approx 10^3 M_\odot$ for clusters out of the relativistic state. In this case only a few percent of mergers end in the BH seeds.

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Slow bars in dwarf galaxies from the Virgo Cluster

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Dwarf barred galaxies are candidates for hosting slowly-rotating bars. They are expected to reside in massive and centrally-concentrated dark matter halos, which should slow down the bar rotation through dynamical friction. When an interaction induces bar formation and when dynamical friction is efficient, the bar should rotate slowly. Despite being predicted within the cold dark matter cosmology, measurements of bar pattern speed, using the Tremaine-Weinberg (1984) method, find that slow bars seem to be rare. We present a photometric and kinematic characterisation of bars hosted by two dwarf galaxies NGC 4483 and NGC 4516 members of the Virgo Cluster. We derive the bar length and strength using the NGVS deep imaging and the circular velocity, bar pattern speed, and bar rotation rate using dedicated spectroscopy from MUSEVLT. By considering the previously studied IC 3167 (Cuomo et al. 2022), we compare the bar properties of the three dwarf galaxies with those of their massive counterparts from literature. Bars in dwarf galaxies are shorter and relatively weaker, and rotate slightly slower with respect to those in massive galaxies, in agreement with theoretical studies and simulations. This could be due to a different bar formation mechanism and/or to the presence of a large dark matter fraction in the centre of dwarf galaxies. We show that it is possible to push the application of the Tremaine-Weinberg method to the galaxy low mass regime, when the targets are carefully selected and dedicated high quality data are available. However, it is necessary to increase the sample of characterised bars in dwarf galaxies to give stronger constraints on their formation and evolution (Cuomo et al. 2024).

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Revealing the effects of environment on Galaxy Bars: The case of the Virgo Cluster

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Bars are hosted in many galactic discs, spanning diverse environments and galaxy luminosities. The environment largely affects the bar formation, with tidal interactions leading to the emergence of these structures within galaxy discs. The bar structural parameters resulting from tidal interactions in high-density galactic environments could differ from those formed through internal disc instabilities in isolated galaxies. To test this scenario, a viable approach is to compare the structural parameters of bars in galaxies situated within distinct environments. We present the comparison between the two key structural parameters of bars, strength and radius, derived using a Fourier analysis on SDSS *r* band images, in galaxies situated within the Virgo cluster spanning a wide range in luminosities and galaxies located in lower density environments. The analysis reveals that the bar radius exhibits a correlation with galaxy luminosity, indicating that larger bars are found in more luminous galaxies. At fixed luminosities, field galaxies display larger bar radii compared to those in the Virgo cluster. However, when the bar radius is scaled by the size of the galaxy, the disparity diminishes. This is because galaxies of similar luminosities tend to be larger in the field compared to the cluster. Consequently, scaled bars in the Virgo cluster and the field exhibit similar sizes. These findings show that the size of galaxies is the parameter influenced by the environment, while the bar radius remains independent of the environment when scaled by the galaxy size. Therefore, internal dynamics and intrinsic characteristics of galaxies play a dominant role in the formation and evolution of bars, regardless of the surrounding environment (Aguerri et al. 2023).

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In the shadows of bright neighbors: The case of CGCG014-074 and NGC 4546

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Early-type dwarf galaxies (ellipticals and lenticulars) represent the numerically dominant population of galaxies in the central regions of rich groups and clusters in the local Universe. As for their origin, several authors postulate that they are the result of the transformation of disk galaxies that fall into these groups and clusters and that this transformation is due to the interaction with the intracluster medium and the other surrounding galaxies. However, the presence of low-luminosity early-type galaxies in low-density environments poses a challenge to this scenario, and the origin of these galaxies in such environments remains unclear.

It is therefore crucial to study these stellar systems in poor groups and the field, focusing on exploring their morphology, dynamics, stellar populations, and observational properties, all of which can help trace their evolutionary history. In this context, we present a comprehensive photometric and spectroscopic analysis of the lenticular dwarf galaxy CGCG014-074, located at a distance of 14 Mpc, using excellent quality data obtained by the Gemini Observatory. Our study entails an exploration of the photometric properties, stellar formation history, and internal kinematics of CGCG014-074 in order to discuss the evolutionary past of the galaxy and the possible genetic link it shares with its neighbour, the massive lenticular galaxy NGC 4546.

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Properties of the spiral patterns of NGC 2619 through morphological analysis

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We performed a morphological study of NGC 2619. This galaxy is located at coordinates 08h 37m 32.706s (RA); +28d 42m 18.70s (DEC) and is classified as isolated (Hernández-Toledo et al. 2010), Seyfert 2 (Toba et al. 2014), SBc(r) in the Hubble system, and AC9 in the Elmegreen system (Buta 2019). Due to the distribution of its spiral structure, this galaxy allows for the investigation of fundamental processes, such as the evolution of the spiral structure, without the direct influence of galactic interactions. For this study we use images from the SDSS project in the *g*-band.

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Tidal stripping and truncation scenario: From dwarf elliptical to Ultra-Compact Galaxy?

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Dwarf ellipticals galaxies (dE) are found at the low luminosity end(>-18 mag) of the elliptical sequence having smaller sizes and lower luminosities than normal elliptical galaxies. Some dE galaxies host a dense central nucleus (dE,N). Further below of the elliptical sequence, at the massive end of the star clusters region, we find massive (>2 $\times 10^6 M_\odot$) and extended objects (r_{eff} between 10 and 100 pc) called ultra compact dwarf galaxies (UCDs). The goal of our study is to investigate if we can transform dE,N galaxies into UCDs, while orbiting a massive galaxy, like the central galaxies of galaxy clusters (tidal stripping and truncation scenario). Is there enough time to strip the dark matter (DM) halo of the dE,N and the stellar envelope to leave just the bare nucleus as the UCD?. On which orbits would we find such UCDs?. In most of our simulations, the dE,N turns into a UCD and the DM halo gets stripped first. The further evolution is governed by the parameters of the stellar envelope and the orbit of the dE,N around the massive galaxy. Massive dE,N either need close peri-center passages or very long evolution times to turn into UCDs.
On eccentric orbits, objects spend most of their orbital period close to apo-center. So even though it is the pericentric passages that do the damage to our objects, the objects need time to lose mass and transform into UCDs further out i.e. closer to their apo-center. Also most UCDs are found close to the apo-center distance today. We see the following order of importance of our starting parameters:
- pericentre distance
- mass of stellar envelope
- size of stellar envelope
- size of DM halo.

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Impact on black hole population due to seed formation in runaway star collisions in nuclear star clusters

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Nuclear Star Clusters (NSCs) are a potential place to form Supermassive Black Holes (SMBHs) in the center of galaxies. In this work, we present an implementation of an NSC model in GALACTICUS, a semi-analytic code designed for simulating galaxy formation and evolution. Our focus is on exploring the role of NSCs during the formation of SMBHs. We assume here that the dominant channel for NSC formation is the transfer of gas from the galactic bulge into a gas reservoir. The gas transfer rate to the center is assumed to be correlated to the global star formation rate in the galaxy, leading to the formation of NSCs through in-situ star formation at the galactic center. Moreover, we introduce a collapse model for NSCs, where they ultimately collapse into a Black Hole (BH) seed upon reaching a critical mass. This critical mass is reached when the age of the NSC exceeds its collisional timescale. By exploring this collapse scenario, we aim to shed light on its potential implications for the population of SMBHs, as well as the relationships between NSCs and galaxies, SMBHs and galaxies, and NSCs and SMBHs. Our investigation delves into how this collapse scenario can impact the overall SMBH population, as well as the intricate connections between NSCs, galaxies, and SMBHs. This research provides insights into the formation and evolution of NSCs and their impact on the galactic and black hole environments. In our results we find SMBHs with masses up to $\sim 10^9\ M_\odot$ at $z = 0$.

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NIR-IFU observations of the Seyfert 2 Galaxy NGC 262

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NGC 262 is a local Seyfert 2 galaxy that hosts a hidden Seyfert 1 nucleus. In this work, we use adaptive optics (AO) assisted, near-infrared (NIR), integral-field unit (IFU) observations of NGC 262 obtained with the Gemini telescope in the J-band to map the distribution and kinematics of the ionized gas in its inner $0.9\,\mathrm{kpc} \times 0.9\,\mathrm{kpc}$ with a spatial resolution of $\approx 55\,\mathrm{pc}$. Recently, Riffel et al. (2023, MNRAS, 521, 1832) used AO assisted NIR–IFU K-band observations of NGC 262 and found that this galaxy presents kinematically disturbed regions (KDR) seen in ionized gas, which they interpreted as being due to nuclear outflows driven by the active galactic nuclei (AGN). Our modelling of the Paβ emission line corroborates these results. In addition, our observations allowed us to map the distribution of the [SIX]λ1.252μm emission line, which has been identified by previous works as a bluewing associated with the [FeII]λ1.257μm emission line and that could not be further characterized due to the lack of spatial resolution.

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Analysis of the expansion of the universe using Large-Scale structures

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The Hubble-Lemaître Law provides a satisfactory description of the universe's dynamics for low red- shifts and reveals insights about its expansion rate. However, at higher redshift values, additional incorporation of the Friedmann equations within the framework of General Relativity is necessary. This project focuses on analyzing large-scale structures of the local universe, specifically at low redshifts, using Hubble-Lemaître diagrams. The goal is to understand the dynamics of universe expansion by studying the Hubble constant independently of specific cosmological models. By utilizing the ALFALFA catalog, the Hubble constant is measured, considering potential systematic effects and using velocity reference frames that minimize peculiar velocity influences. Transformations of frames of reference, e.g. Local Group and CMB frames, and statistical methods were employed to achieve a more accurate determination of the Hubble constant. Within a 1 sigma confidence level, the values for the Hubble constant are equivalent between the two hemispheres. The findings of this work, which contributed to the publication of an article, shed light on the precise measurement of the Hubble constant and its implications.

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The DIVING^{3D} project: A deep look on the central region of Early-Type galaxies

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An active galactic nucleus (AGN) arises when a considerable quantity of matter is accreted onto super-massive black holes (SMBHs). In elliptical and lenticular galaxies from the local Universe, low-luminosity AGNs (LLAGNs), usually with LINER-like spectra, are predominant. In Ricci et al. (2023, MNRAS, 522, 2207), we presented the final results on the nuclear region of all 56 early-type galaxies (ETGs) from the DIVING^{3D} project, which is a statistically complete sample containing all galaxies from the Southern hemisphere brighter than 12.0 mag (B-band) and galactic latitude $|b| < 15^{o}$. All observations were performed with the GMOS-IFU instrument installed at the Gemini South telescope. We detected emission lines in 86±5% of the objects. In 52±7%, the emission was classified as characteristic of LINERs or Seyferts. No emission of the Hβ or the [O III]λ5007 lines was detected in the other 34±6% of the ETGs. Given their low values of the equivalent width of Hα, we classified them as weak emission line objects. No Transition Objects (composite HII/LINER spectra) were detected in the sample. Broad components are seen in the Hα line of 29±6% of the nuclei. In 41 out of 48 galaxies with ionized nebulae, the source of ionization for the LINER spectra and for some of the weak emission line objects is likely due to a LLAGN, although some of the objects require shocks to explain high values of the [O I]λ6300/Hα ratio.

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Exploring the environments and internal dynamics of relics and compact massive ETGs with TNG50

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Relic galaxies are massive, compact, and quiescent objects observed in the local Universe that have not experienced any significant interaction episodes or merger events since $z \approx 2$, remaining relatively unaltered since their formation. These galaxies with "frozen" history can provide important clues about the intrinsic processes related to the formation and evolution of massive Early-Type Galaxies (ETGs). Using the high-resolution cosmological simulation TNG50-1 from the Illustris Project, we investigate the assembly history of a sample of massive, compact, old, and quiescent subhalos split by 10% of satellite accretion fraction. We compare the evolutionary pathways at three cosmic epochs: $z = 2$, $z = 1.5$, and $z = 0$, using the orbital decomposition numerical method to investigate the stellar dynamics of each galactic kinematical component and their environmental correlations. Our results point to a steady pathway across time that is not strongly dependent on the mergers or the environment.

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UV spectral characterization of quasars

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Active Galactic Nuclei (AGN) are defined based on the accreting material towards the supermassive black hole. The nuclear activity is detected at all wavelengths as a product of the different emission regions, resulting in a great diversity of observational features. The Eigenvector 1 (E1) parameter space has allowed us to organize the AGN diversity based on their observational features in the optical to X-ray ranges. In particular, the E1 optical space has been developed as a "Main Sequence" for quasars using optical spectra. However, a more detailed analysis of the UV region is still missing. The main goal of this work is to classify spectroscopically a sample of 1565 SDSS-V quasars with high redshifts ($z > 1.09$) from the information provided by their UV CIII]λ1909/SiIII]λ1892 and AlIIIλ1860/SiIII]λ1892 emission line ratios, to build a diagram that allow us to distinguish the differences between the AGN of the selected sample. With this classification, we divide our diagram to have average spectra to analyze them individually. We also propose this diagram to organize UV quasar spectra by their intrinsic physical characteristics calculated from the average spectra.

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Use of neon lines in the study of the components present in SEDs of Seyfert galaxies

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The emission line of [Ne V], in infrared, has proven to be a relevant indicator of the activity of an AGN due to its high ionization potential. Likewise, the analysis of the ratio [Ne V]/[Ne II], has allowed to distinguish between stellar environments and AGNs. Based on the above, this work sought to verify from a sample of Seyfert galaxies taken from the CDS-SIMBAD database, that the estimates of the AGN fraction (f_{AGN}) coming from a spectral energy distribution (SED) modeling tool (CIGALE), coincide with the Neon line tracers in the infrared. From NED tables, galaxies containing data on the lines [Ne II]12.8μm, [Ne V]14.3μm and [Ne III]15.5μm were filtered from the initial sample. [Ne V]/[Ne II], [Ne V]/[Ne III] and [Ne III]/[Ne II] ratios were compared with the different physical properties estimated from the best SED model of each galaxy. It was found that, if the entire sample of Seyfert galaxies is taken as a single dataset, it shows a moderate positive correlation between the estimated f_{AGN}, and the [Ne V]14.3μm/[Ne II]12.8μm line ratio with a *Pearson Correlation Coefficient (PCC)* of 0.54, and statistically significant ($p-value = 9.74e-8$) But, if the sample is split according to their classification (obtained from SIMBAD) between Seyfert-1 (Sy1) and Seyfert-2 (Sy2), we found that the correlation is strong only in Sy1 galaxies ($PCC = 0.66$, $p - value = 1.66 \times 10^{-6}$), but weak in Sy2 galaxies ($PCC = 0.28$, $p-value = 0.083$). This same pattern occurs by classifying galaxies by their viewing angle (i) to the torus, and the luminosity of the AGN disk (L_{AGN}^{disc}).

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Using WISE cataloged data for morphology, bulge fraction and Black Hole mass estimation

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We present WISE2MBH, an efficient algorithm for estimating parameters of galaxies and their supermassive black holes (SMBH). Using cataloged photometric data from the Wide-field Infrared Survey Explorer (WISE) and employing scaling relations, WISE2MBH estimates the morphological type, bulge fraction, bulge mass and SMBH mass ($M_{\rm BH}$). The algorithm uses WISE color-color criteria to classify between powerful AGN/QSO and regular galaxies, determine the morphological type and bulge fraction using of functional fits developed by us, using WISE data calibrated against morphological classifications from the 2MASS Redshift Survey (2MRS) for the former and a compilation of bulge fractions available in the literature for galaxies with known morphology for the latter. With K-corrections applied, WISE2MBH performs well up to $z \sim 0.5$. Compared to a sample of local galaxies with measurements and high-precision estimates of $M_{\rm BH}$, our algorithm shows optimistic results, with a Spearman score of ~ 0.8 and an scatter of ~ 0.52 dex. Applying WISE2MBH to the Event Horizon and Environs (ETHER) sample with $z < 3$ yields approximately 2.4 million $M_{\rm BH}$ estimates and 650 thousand $M_{\rm BH}$ upper limits; $\sim$ 80% of these lack previous $M_{\rm BH}$ estimates. For the local universe, the black hole mass function (BHMF) obtained from the sample is in good agreement with predictions from multiple works. Our algorithm will be a valuable tool for target selection for the Event Horizon Telescope (EHT). The WISE2MBH algorithm is publicly available on GitHub.

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Comparing the GW170817 source with type Ia Supernova light curves: Do they converge to the same value of H_0?

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The objective of this study is to answer if it is possible to carry out measurements of cosmological distances, complementing type Ia supernovae with the merger of black holes, evaluating if it is possible to refine the measurement of the accelerated expansion of the Universe, through the detection of waves, gravitational waves generated by the merger of black holes by comparing them with the intrinsic luminosity of type Ia supernovae. The methodology used is shown with the results obtained in the previous work, to contrast the simulation results with the result obtained. This work extends the methodology of the previous work, contrasting the virtual results with those obtained in the publication of the work "A gravitational wave standard siren measurement of the Hubble constant", applying a novel approach to measure the Hubble constant by means of the gravitational waves, applying for the first time a revolutionary method proposed 30 years ago by Bernard Schutz using the source GW170817, detected by advanced LIGO and advanced Virgo on August 17, 2017. The analysis of the shape of the gravitational wave by the merger of black holes or neutron stars allows us to estimate the distance, which allows us to compare, according to the environment of the host galaxy, in relation to its environment, the comparison of light curves of supernovae type Ia contrasting the results, in the distance and how much is the result of H_0.

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Star formation efficiency per free-fall time in a galaxy merger

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We present the results of a Mitacs Globalink Research Internship to analyze the star formation efficiency per free-fall time in NGC 3256 using a method published by Utomo et al. (2018). NGC 3256 is a luminous infrared galaxy at redshift 0.00935. This galaxy is the merger of two gas-rich galaxies and the southern nucleus has a jet driven by an active galactic nucleus. In general, low values of star formation efficiency per free-fall time correspond to mostly high values for star formation rate in NGC 3256. We found that there are 5 locations that do not follow that trend. The lowest value corresponds to the location of the jet of the southern nucleus, which seems to be suppressing the star formation in this part of the galaxy. In addition, two of the lowest values of star formation efficiency per free-fall time are located in a tidal arm, where tidal forces could shear the gas producing low values of star formation rate.

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Accretion disk study of the AGN ESO 362-G18 through reverberation mapping

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In this work, we apply the Reverberation Mapping (RM) technique to estimate the geometry and size of the accretion disk of Active Galactic Nuclei (AGN) ESO 362-G18 using X-ray/UV/Optical observations provided by the Swift space telescope. Advanced techniques such as PyCCF, JAVELIN, and PyROA codes were used to quantify the relationship between temporal variability and AGN lagtimes with respect to a reference light curve in the UV band (1928 Å). To obtain lagtime versus wavelength results, we fit a curve that varies certain model parameters and calculate the χ^2 parameter to compare the best fits. These results give us a deeper knowledge of the physical and dynamical properties of the ESO 362-G18 and its active nuclei, providing advances to the field of AGN astrophysics and knowledge about supermassive black holes (SMBHs) and their interactions with the surrounding galaxies.

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Cosmic rays at the epoch of reionization

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One of the most important open problems in Cosmology is that of the reionization of the intergalactic medium (IGM) during the Cosmic Dawn. Radiation produced by the first galaxies would not have been enough to maintain the ionization fraction of the IGM at large scales. Consequently, complementary ionization agents have been proposed, such as the cosmic rays that escape from the same galaxies. In this work, we investigate the ionizing mechanisms allowed by electron-initiated electromagnetic cascades as they propagate across the IGM, emphasizing the contribution of secondary photons, which has not been extensively explored before. We simulated the transport of all the particles comprising the cascades and calculated both the ionization rate and the energy distribution between the particles and the IGM. Our results show that high energy electrons carry energy far away from the source while ionizing the medium in their path, whilst those with kinetic energies lower than a few keV cool completely through collisional ionization within a distance of the order of kiloparsecs, reinforcing the results of previous works and extending their predictions to higher energy electrons and farther distances from the source. In addition, we show for the first time that photoionization by secondary photons produced in high-energy cascades may contribute significantly to the ionization of the IGM. This remarkable result implies a significant ionization rate in the deep IGM that has not been considered before and could provide an efficient mechanism to maintain the ionization fraction at large scales.

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Metal enrichment of galaxies inhabiting halos of different masses in a Λ-CDM cosmology

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The chemical properties of the baryonic components of galaxies encode crucial information about the formation and evolution of the structure in the Universe. In this work, we study the chemical evolution of galaxies since early cosmic times until the present by using state-of-the-art numerical cosmological simulations. We analyze the evolution of nuclei abundances of galaxies inhabiting halos of different masses, considering physical models corresponding to different feedback scenarios. We pay particular attention to the connection between the chemical properties of different baryonic phases in galaxies (e.g. cold gas, hot gas, stellar component) and try to determine the existence of scaling relations between them which can be compared with observational data.

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Investigating the resilience of dwarf spheroidal galaxies within the gravitational potential of the Milky Way

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Satellite galaxies of the Milky Way (MW) are of utmost importance for the construction of the history of formation and evolution of the Galaxy. In particular, many of these satellites are dwarf spheroidal (dSph) galaxies, which appear in a variety of degrees of dynamic destruction. Beyond that, better understanding the dynamics of these objects as they interact with the MW is crucial because their remnant stellar structures, such as stellar streams, allow us to constrain dark matter models. Therefore, the aim of this work is to use numerical simulations to investigate which orbital and structural features make a dSph galaxy more or less resilient to the forces imposed by the gravitational potential of the MW. To achieve this, we carried out simulations of semi-analytical models: N-body systems (Plummer spheres representing dSph) immersed in a realistic analytical potential of our galaxy. We considered both parallel and perpendicular orbits to the disk of the MW in two cases: circular and rosette-shaped orbits, while keeping track of the mass inside the cores of the spheres. We were able to demonstrate that, for all tested orbits, there seems to exist a direct relation between the central density of a Plummer sphere and the time it takes for it to lose a certain percentage of the mass inside its core. For the rosette-shaped orbits, we also found that the pericentric passages are the most intense moments in regards to the loss of mass of the core, although the apocenter is also significant if it's in a sufficiently sharp turn. However, it was also possible to show that the core can retrieve a relevant quantity of mass during the approaches to the pericenter depending on the interplay between the central density and the general size of the orbit.

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Spatially resolved observations of the peculiar galaxy NGC 232: AGN winds and stellar populations

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We use VLT-MUSE data to explore the ionized gas properties and kinematics as well as star formation history, and chemical abundances of the Seyfert 2 galaxy NGC 232. The data cover a field of view of 60×60 arcsec^2 at a spatial resolution of ∼850 pc. We fit the emission-line profiles with two Gaussian components, one associated to the emission of the gas in the disk and the other due to a biconical outflow. The previously reported jet-like optical structure in this galaxy seems to be associated to the emission of the closer wall of bicone. We have found that the stellar population is predominantly older than 2 Gyr. The AGN seems to quench the star formation in the inner 2 kpc. On the other hand, a higher contribution of younger stellar populations is seen surrounding the walls of the bicone, suggesting a both negative and positive feedback scenario. Regarding the chemical abundance, AGN-dominated and SF-dominated regions show similar abundances of oxygen, leading to the conclusion that both phenomena are being fed from a shared cold gas reservoir.

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Measurements of black holes masses using photometry in high redshift quasars

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We aim to determine the validity of the mass-obtaining method by adjusting the spectral energy distribution using only photometric data. We use the code BADFit (Lai et al. 2023) that computes the fit using *kerrbb* and *slimbh* models from XSPEC, depending directly on the photometric points. We measure black hole masses for 30 quasars in a redshift range of $5.8 < z < 6.6$ belonging to the XQR-30 sample, which includes each object's J, H, K photometry bands (D'Odorico et al. 2023). To complement this information the z, y, W1, and W2 NIR bands were searched for VizieR. The code also uses Bayesian inference to detangle the inner degeneracy of the parameters: mass, accretion rate or luminosity, inclination and spin, after XSPEC gives the possible models. Both models give similar results, with an average error of $\log(M/M_{\odot}) = 0.2$. A comparison between our results and ones using Single-Epoch MgII (Mazzucchelli et al. 2023) shows no significant statistical correlation. With values of $\rho = 0.3$ (p = 0.10) and KS = 0.33 (p = 0.07), the correlation between the masses is moderately low and not very significant. We repeated the analysis considering objects at z<6.1, where values of $\rho = 0.37$(p = 0.14) and KS = 0.24(p = 0.75) are obtained, indicating a small improvement in the correlation but a decrease in significance. We conclude that in quasars at z>6, the Gunn-Peterson effect inflates mass estimates, which can explain inconsistencies in the full sample. Using only photometric data, the analysis of problematic quasars suggests correcting some spectroscopic lines to improve SED placement and mass measurements.

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Revealing the orbital histories of strongly perturbed galaxies in the Abell Cluster A496

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We study a sample of disturbed spiral galaxies in the nearby and apparently relaxed cluster A496 ($z = 0.033$). This work is based on a large volume, HI (21cm) survey from the NRAO-VLA, as well as multi-band optical, NIR (CFHT), and FUV (UVIT- Astrosat) imaging. In a previous work, we reported an intriguing HI galaxy distribution with a large fraction of HI rich galaxies within the densest cluster region. In this work we analyze the orbital histories of both, HI-detected and non-detected spirals based on the projected phase-space (PPS) distribution. The study of the galaxy orbits combined with the HI disruptions helps to explore the role played by different physical mechanisms driving the transformation of galaxies observed in this cluster. This strategy allowed distinguishing galaxies under ram-pressure stripping from those affected by tidal interactions.

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Perturbation effects and the evolution of gLSBGs: The case of *Malin 1* - Past interactions with satellite galaxies

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We study the environment of the giant low surface brightness galaxy *Malin 1* analysing the orbital history of its satellite galaxies by exploring possible close encounters in the past. We find orbits with trajectories that can connect the location of the satellite *exo-Malin 1* with an observed stellar stream candidate, which could indicate that *Malin 1* had a satellite interaction ~ 3 Gyr ago.

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Ultra diffuse galaxy formation constraints and possible detection in S-PLUS images

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In this poster we present our ongoing work in the formation scenarios on Ultra Diffuse Galaxies (UDGs) and their Globular Cluster (GC) populations. UDGs are Low Surface Brightness galaxies with abnormally big effective radii for this mass range (> 1.5 [kpc]). To probe their formation histories, we fit Skewed-gaussian functions to the Globular Cluster Luminosity Functions (GCLFs) of the UDGs using a kernel density estimation and retrieving the Skewed-gaussian parameters via the minimization of the negative log-likelihood function between the KDE and the Skewed-gaussian function. Comparing the parameters of turnover magnitude and standard deviation of the GC Skewed-gaussians of dwarf galaxies in Virgo and Fornax two outlier UDGs are identified, namely NGC1052-DF2 and NGC1052-DF4 (from now on DF2 and DF4 respectively). DF2 and DF4, UDGs lacking dark matter, presents abnormally luminous GCs, with a turnonver magnitude $\sim$ 1.5 [mag] higher than the Universal GCLF peak. Another interesting case is DGSAT-I which is an isolated UDG with an overmassive dark matter halo for it's stellar mass and a spatial distribution of GCs more extended than DF2 and DF4. We also present our future work with the SPLUS survey in the context of the S-PLUS Fornax Project (S+FP) to search for UDGs in the 106 fields of S+FP which covers the Fornax Cluster to $\sim 5R_{\rm eff}$; this is motivated by the detection of Low Surface Brightness galaxies in the S-PLUS data using the SExtractor package.

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Exploring the dynamical systems and observational constraints of cosmological models with mimetic gravity

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The Λ-CDM model has been supported by observations of the Cosmic Microwave Background (CMB), Supernovae type Ia (SNIa), the Hubble parameter and Baryonic Acoustic Oscillations (BAO), and yielded cosmological parameters with precisions of the order of one percent (e.g. CMB analysis). Nevertheless, there are still theoretical and observational claims that depart from the Λ-CDM paradigm. This opens the door to explore alternatives such as the modified gravity theories, ($f(R)$). In this poster, we considered the mimetic gravity that provides a geometric description of dark matter. We presented the dynamic description of the isotropic and homogeneous Friedmann-Lemaître-Robertson-Walker cosmological models with positive spatial curvature coming from mimetic gravity theory. The phase space obtained allow us access to solutions that can represent different stages of the cosmic evolution. The dynamics on invariant submanifolds provide good portrait of the system and its respective neighbourhoods. We therefore can obtain properties of the cosmological models that can be compared with the Observational Hubble database from the cosmic chronometers (OHD) and the Pantheon database from Supernova type Ia (PaSNe). We showed a brief discussion on the observational properties of the ΛCDM models and on cosmological models for mimetic fields with exponential potential (EP) and with inverse quartic potential (IQP), with emphasis on the cosmological constraints provided by this study. From the observational analysis, we provided weak constraints on the main parameters of the EP ($\alpha = 18^{+19}_{-28}$) and IQP ($\beta = -369^{+970}_{-470}$) models. We will explore new priors on parameters such $\Omega_{k,0}$, H_0, as well as on the α (EP) or β (IQP). In addition, we will include the CMB data.

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Ionized gas winds from the nucleus of OH megamaser galaxy IRAS 09320+6134

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Ultra luminous infrared galaxies are extremely bright objects in this spectral range, with luminosities larger than 10^{11} $L_{\odot}$. These objects are commonly seen in mergers of galaxies and are propitious environments for the emission of OH megamasers, luminous and powerful extragalactic masers. Many of the OHM galaxies present a composite spectrum, both with characteristics of intense star formation (Starbursts) and with an active galactic nuclei (AGN). IRAS 09320+6134 is part of a project whose general objective is to relate the properties of the OHM emission and the merger stage of its host galaxy with possible AGN and/or SB activities, in order to better understand the nature of the ionization mechanism of galaxies that present this phenomenon. Observations were performed with GMOS-IFU, on Gemini North telescope. We obtained measurements of the gas kinematics by fitting the emission line profiles with two Gaussian curves each, using IFSCube code. The narrow component is tracing gas emission in the galaxy's disk, shows extended emission for all lines in the whole field of view and its velocity fields show a rotating disk, with amplitudes of $\sim$ 200 km/s. The broad component, interpreted as being due to an outflow of ionized gas from the galaxy's nucleus, shows emission mainly in the central 1.5″ for all lines and its velocity fields presents only negative velocities, with amplitudes of $\sim$ −800 km/s. BPT and WHAN diagnostic diagrams indicate ionization due to an AGN for both components. Outflow properties indicate that its kinetic power is about two orders of magnitude less than the values estimated by cosmological simulations for the AGN feedback to be efficient in suppressing star formation.

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Evolution of low mass dwarf disk galaxies

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Dwarf Spheroidal (dSph) Galaxies are the smallest (10^4 − $10^7 M_{\odot}$, $r_{\rm eff}$ $\sim$ 250 pc) galaxies, their dynamics dominated by their large contents of dark matter. Under the Λ-Cold Dark Matter paradigm, larger galaxies were formed as smaller galaxies merged with each other, making dSphs the basic building block of galaxies. The current dSph satellite population of the MW corresponds to the leftovers of the formation process of the MW. As gas falls into the DM halos, angular momentum conservation will imprint a rotation signature on the system. So far, no rotationally supported, isolated dwarf galaxies have been found. This may be due to different reasons: a) These objects may be faint enough to evade our current efforts to find them. b) Additional internal processes destroy the original rotation signature. c) They are born as pressure supported systems in the first place. We aim to investigate this second option. We use the Dissolving Clusters Model to construct an isolated disk galaxy, and study the evolution of its velocity profile for 10 Gyr. Due to the random motions of the stars within their native clusters, the majority of ejected stars will move in the same direction as the cluster was orbiting the halo, but a fraction of them will gain radial, or even retrograde, orbits, increasing the velocity dispersion of stars in the disk. Reducing the mass of the DM halo increases the number of stars moving against the bulk of the disk. Even at low DM halo mass, even below the star formation limit, there is still the signature of rotation, which persist at all times. This means that if disks, or rotationally supported systems, were able to form at these mass ranges, we would be able to see them on isolated regions.

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Exploring the evolution of galaxies: A comparative study using two Semi-Analytic Codes

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In this study, we compare two semi-analytic models of galaxy evolution, SAGE and GALACTICUS. Our aim is to compare their results and understand their agreement or divergence. We use the Millennium run N-body simulation as input, the Millennium run I with SAGE and the mini-Millennium I with GALACTICUS. We employ a minimal set of physical processes to analyze the performance of the models focusing on statistical analyses . We use similar physical parameters. We examine key aspects including black hole population and galaxy properties, seeking to unravel their strengths and weaknesses. We find that the black hole mass distribution tendency is similar in the models but the mass range is different. Also, the normalized frequency has a different scale. This research contributes to the advance of our knowledge in the galaxy evolution providing insights into the complex process involve.

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The formation of faint and Ultra-Faint dwarf spheroidal galaxies: Modeling the formation of Ursa Major II using AMUSE

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Faint and Ultra-Faint dwarf (UFD) spheroidal galaxies represent an extension of the classical Milky Way satellites to lower luminosities and smaller physical sizes. In this project, we perform numerical simulations using the Astrophysical Multipurpose Software Environment (AMUSE) and the N-body code ph4 to study a new formation model for UFDs galaxies: the dissolving star cluster scenario. We use the UFD Ursa Major II (UMa II) as reference galaxy to probe our formation scenario. We consider 4000 stars with virial equilibrium velocities and equal masses ($M_* = 1\ M_\odot$), representing the total luminosity of UMa II. The stars are randomly placed in a fractal distribution inside the central part of a cored DM halo modeled as an analytical Plummer potential, building up the luminous component of the galaxy. We vary the maximum extension of the fractal distribution ($R_{fractal}$ = 100, 125, 150, 175 and 200 pc) as well as the scale-length of the cored DM halo (R_{pl} = 50, 100, 150, 200, 250, 500 and 1000 pc), to explore the influence of both parameters on the final object. We follow the evolution of the stellar distribution for 5 Gyr. Our results of 175 simulations indicate that all our fractal initial stellar distributions evolve into a typical UFD within 2 Gyr of evolution. This saves a lot of CPU-time as we do not need to follow the evolution all the way to 12 Gyr, that is, the age of the UFDs. We find that the size of the resulting UFD galaxy depends mainly on the scale-length of the analytical DM halo and only marginally on the initial size of the fractal. In essence, this implies that by measuring the half-light radius of the UFD we can deduce the scale-length of the DM distribution. On the other hand, measuring the velocity dispersion of our objects within their half-mass radius we obtain values higher than observed in UMa II.

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Quenching of star formation in galaxies up to large clustercentric distances

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It is well known that galaxy properties depend on their environment, with overdense regions having a low fraction of star-forming galaxies ($f_{\rm SF}$). However, it is unclear how galaxy properties such as velocity dispersion (σ), stellar mass (M_*), group halo mass (M_h), AGN activity, etc., collectively influence the $f_{\rm SF}$ along the clustercentric distance ($R/r_{\rm vir}$), where R is the projected distance and $r_{\rm vir}$ is the virial radius. In this context, we use a complete sample of galaxies in the Sloan Digital Sky Survey's Data Release DR18 along with a logistic regression model to account for the nine different galaxy properties across their entire range of values without binning to investigate how the $f_{\rm SF}$ varies with galaxy properties as a function of $R/r_{\rm vir}$ up to 20 virial radii. Also, we explore the effect of two different star formation rate (SFR) measurements in the $f_{\rm SF}$: one using Hα emission line and the other using UV/optical spectral energy distribution (SED). Our results show that, in general, $f_{\rm SF}$ increases with $R/r_{\rm vir}$, with σ and AGN activity playing a more important role in determining how the $f_{\rm SF}$ varies. Furthermore, when various galaxy properties are taken into account, the dependence of $f_{\rm SF}$ on $R/r_{\rm vir}$ is significantly smaller, being important only for non-AGN galaxies and galaxies with σ values between $1.9 < \log_{10}\sigma < 2.1$. Although the trends in the result are maintained, the extent and variations of $f_{\rm SF}$ depend significantly on the different SFR estimation methodologies.

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The mystery of extremely HI Rich galaxies

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The properties of most galaxies in the universe follow scaling relations related to the physics that govern galaxy evolution. For example, there are scaling relations between the stellar mass of late-type galaxies and their neutral hydrogen (HI) content. Based on these scaling relations we can also identify unusual galaxies, such as HI-deficient galaxies with relatively low HI content and HI-excess galaxies with relatively high HI mass compared to their stellar mass. The possible reasons for the later could be either recent gas accretion or an inefficient conversion of the HI to molecular gas. Since recent gas accretion is difficult to prove conclusively, we investigated gas conversion by analysing the molecular gas content of five extremely HI rich galaxies from the HIX galaxy sample. Carbon monoxide (CO) is a good tracer of the molecular gas content of galaxies, so we obtained CO observations of the sample galaxies with the Atacama Large Millimeter Array (ALMA). We obtained resolved CO maps from which we derived the mass and the distribution of the molecular gas in each of the galaxies. We analysed the kinematics of the molecular gas disks and compared it to the HI, stellar and star formation properties of the galaxies. While we find that our sample galaxies have relatively regularly rotating molecular gas disks, their molecular gas fraction is significantly lower than what is expected from scaling relations.

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Unraveling the sagittarius dwarf spheroidal galaxy at low galactic latitudes

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The Sagittarius dwarf spheroidal galaxy (Sgr) is one of the Milky Way's nearest and most massive satellites. It is being disrupted by the tidal interaction with the Milky Way's gravitational potential, leading to a giant tidal stream that covers a large portion of the sky. As seen from Earth, the core of Sgr lies a few degrees below the Galactic plane, behind the Galactic center; meanwhile, the streams are almost perpendicular to the Galactic plane. Since its discovery, Sgr has been extensively studied; however, the regions at low Galactic latitudes still need a proper analysis, which has been prevented due to the high reddening and significant crowding present in this region. The wide-field, high-resolution, near-infrared coverage of the Vista Variables in the Vía Láctea (VVV) survey is a promising alternative for studying Sgr at low Galactic latitudes. Building on previous research leveraging VISTA capabilities for Sgr analysis, we seek to further our understanding of this dwarf galaxy using the improved VVV-X coverage in synergy with the Gaia DR3 survey data.

We present the preliminary results of the decontamination algorithm employed to separate the stars of Sgr from the field. The algorithm consists of a multidimensional mixture model in the parameter space of proper motions, parallax, spatial distribution, and near-infrared PSF photometry in the bands J, H, and K_s. The model's parameters are obtained following the expectation/maximization algorithm. As a result, we could get a sharp classification of objects covering the area at $0° < l < 11°$ and $-4° < b < -14°$. These results provide a step forward in understanding the intricate characteristics of the Sgr at near-infrared wavelengths and give a better map of the structure of the Sgr and its streams at low Galactic latitudes.

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The dynamically active NGC 5098 group: Sloshing and diffuse intragroup light

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Galaxy groups play an important role in galactic evolution, where galaxies may strongly interact with one another and with the intragroup medium. These groups may later fall into clusters, participating in the development and growth of the large-scale structure. In this study, we examine in detail the group dominated by a pair of elliptical galaxies, NGC 5098, which exhibits a sizable substructure to the south. Using deep g and r imaging from CFHT/MegaCam, we detected a significant component of diffuse intragroup light and a low surface brightness star-forming object. By analyzing the velocity distribution of galaxy members, we propose a dynamical scenario for the evolution of this group, taking into account the sloshing phenomenon detected in the X-ray surface brightness observations made with the Chandra space telescope.

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Probing a protocluster candidate at $z \sim 4,5$ in the COSMOS field

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The densest structures of the Universe formed at the knots of the cosmic web at high redshifts and constitute the present-day clusters of galaxies. They are nearly virialized systems, with a high density of gravitationally bound galaxies. The early stages of these structures are called protoclusters and they are the natural laboratories to observe the role of environmental effects on galaxy evolution. In this work we use submillimeter galaxies (SMGs), which are dusty and highly star-forming galaxies, expected to inhabit peaks of matter density at high redsfhift, as targets for protocluster searches. We use combined wide-band and narrow-band optical photometry to identify Ly-alpha emitters (LAEs) around SMGs at $z \sim 4.5$ in the COSMOS field, as a means to identify typical star-forming galaxies tracing the underlying structure that harbors our target SMGs. Our approach picks out line emitters as narrow-band excess objects, which we designate as Ly-alpha candidates. We use additional IMACS spectroscopic data to confirm these candidates as bona fide LAEs and thus protoclusters members, eliminating low-redshfit interlopers. Our preliminary results point to a mild excess in LAE density around SMGs at $z \sim 4.5$ in comparisson to the field. These preliminary results are consistent with SMGs tracing typical moderate-mass structures of the Universe instead of the more massive ones, that grow into Coma-like clusters. SMGs may be thus an as-yet untapped population to understand the build-up of the more modest and typical galaxy groups and clusters.

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PAH Astrochemistry – Spying on the underlying power source in Dust-Rich galaxies

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One of the most challenging aspects of studying the interstellar medium (ISM) of active galaxies is the intense obscuration by dust. This phenomenon raises debates about the power engine of active galaxies: star formation activity, nuclear activity (AGN), or a combination of both. One way to investigate this issue is by inspecting the dust, particularly the Polycyclic Aromatic Hydrocarbons (PAHs). This class of complex molecules, detected by their broad features at mid-infrared, is a tracer of ionizing radiation by young stars, ubiquitous in the universe, and, more recently, has been found even in circumnuclear regions of AGN. In this work, we use low-resolution spectroscopy by IRS/Spitzer to probe the ISM astrochemistry in 600 dust-rich galaxies to explore the relationship between PAH molecular diversity (size, charge, and composition) and the AGN strength. We use a sample of dusty galaxies (0<z<3.7) encompassing different nuclear activity degrees, such as pure starbursts, U/LIRGs, Seyfert galaxies, and quasars. We proceed with a spectral decomposition and a molecular breakdown, using a suite of theoretical spectra from PAH vibrational transitions. We notice PAH infrared emission is well represented by neutral, small (<50 atoms of Carbon), and pure molecules (with no metal, except Carbon). We see stronger AGNs seem to host more neutral PAHs (77% ±15%) than star-forming galaxies (56%±10%), which can be explained by shielding of molecular gas and photochemical processes, such as electronic recombination and PAH dehydrogenation, where the latter may be favored in stronger AGN. These results help us to understand how the dust is affected by the coexisting AGN and star formation bursts that occur in the evolution process of gas-rich galaxies.

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Morphological study of active galaxies

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Three pairs of galaxies were studied in the g and i bands in which, in each pair, the galaxies share the same morphological structure, but one of them has an active nucleus (**AGN**), while the other does not. The images of the galaxies underwent standard processing and then the morphological characteristics were determined by applying the two-dimensional Fourier transform. With this, the aim of the work was to study the influence of galaxy morphology on nuclear activity.

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The environment of LBAs in the S-PLUS

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High-redshift galaxies form more stars per unit of time compared to galaxies in the local universe. However, it remains unclear whether the trigger for this high star formation rate is related to interactions with the environment or star formation in clumps, due to disk instabilities. The main goal of this project is to investigate the environment of high-redshift analogues, such as Lyman Break Analogues (LBAs), to better understand the influence of the local environment on their properties. Subsequently, these results will be compared with galaxies in the distant universe to evaluate the influence of the local environment on the formation of galaxies 10 billion years ago. Our methodology involves a code that analyzes the fields of the galaxies and measures their respective densities using the k-th nearest neighbor method with $k = 4$, $k = 5$ and $k = 10$. The values of the densities are then compared for different ks. This algorithm was applied to all the galaxies in the DR3 S-PLUS. To evaluate the completeness of our sample, a Schechter function was fitted over the luminosity distribution. The densities were then plotted against galaxy properties to test the robustness of our catalog, and the known relations were successfully recovered. The catalog will be available to the public via the S-PLUS database.

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Neighbourhood watch: A survey of Baryonic substructures in the nearby Universe

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The Neighbourhood Watch is a survey to complete a census of all baryonic structures out to at least the virial radius in a sample of galaxy groups within 18 Mpc in the optical filters $u'g'r'i'$ and $H\alpha$ with CTIO/DECam and in the NIR J,K filters with ESO/VIRCAM. The observations reach unprecedented point source depths of 2.5 magnitudes beyond the peak of the globular cluster luminosity function (GCLF) which will detect > 99% of all compact objects, i.e. globular clusters (GCs) and ultra-compact dwarf galaxies (UCDs), and reveal all low-surface brightness baryonic structures down to ∼28mags/arcsec^2. This dataset will allow for the first time: to derive a complete GCLF out to the virial radius for these galaxies, to search for spatial over-densities and unique age/metallicity distribution functions in the GC population, to detect 10-100 new low-surface brightness dwarf galaxies for each target group to test current state-of- the-art cosmological simulations and to measure their luminosity function in different environments, and probe the complex interaction/merger/accretion history of these groups. Given the DECam community pipeline's inability to properly determine the sky levels around large galaxies, a custom data reduction pipeline has been designed for this particular dataset that employs a combination of different image processing techniques (convolution masking, distortion reduction in chip gaps, adaptive sky modal) leading to improved retrieval of low- surface brightness dwarf galaxies in the final stacks. This poster provides an overview of the survey and present analysis of the final stacks in relation to the objectives mentioned above.

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A comparative of two dual AGNs mergers

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The evolution of galaxies and its connection with Active Galactic Nuclei (AGN) feedback on either suppressing or enhancing star formation remains a subject of ongoing discussion. This research investigates the link between the evolution of Super Massive Black Holes (SMBHs) and their host galaxies through merger galaxies, focusing specifically on rare cases of dual AGN. From integral field spectrograph (IFS) observations, we compare two merging galaxies: SDSS J1414-0000 (z=0.0475) in the early stages of collision; and SDSS J1544-0441 (z=0.042) in a more advanced stage, with projected nuclear separations of ∼ 4.9 kpc and ∼ 3.4 kpc respectively. The two objects have AGN signs on both nuclei, based on the data from the Chandra X-ray Survey. Instrument artifacts and telluric emission lines were identified and removed using PCA, and the stellar continuum signal was enhanced through Voronoi binning. In order to derive the stellar continuum we employ STARLIGHT and for fitting the emission line profile of ionized gas we use IFSCUBE. We noticed that the absence of features common to more advanced stages (tidal tails, stellar bridges, stellar halos, complex kinematics) in SDSS J1414, suggests that these galaxies are experiencing their first perigalactic passage. Furthermore, despite being confirmed as a dual AGN through X-ray observations with a column density $N_H < 10^{23}$, the lack of a broad line in one SDSS J1414 nucleus, also suggests its recent activation. In the future, we aim to refine the fit and address uncertainties associated with it, as well as conduct a more detailed comparative analysis of the galaxies SDSS J1414 and SDSS 1544.

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Stellar mass distribution in barred galaxies through Multi-Band decomposition in the Mid-IR

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Bars are elongated central structures composed of gas and stars, frequent in the Local Universe. They are present in $\sim 65\%$ of spirals and strongly transform their host galaxies. We use 3.6 and 4.5 μm imaging for 371 barred galaxies from the Spitzer Survey of Stellar Structure in Galaxies (S^4G, a mid-IR survey of > 2300 nearby, large and bright galaxies). Suffering no dust extinction and being dominated by the emission of low mass stars, the mid-IR is the best tracer of stellar mass in galaxies. We use the S^4G team's GALFIT-based decomposition of the 3.6 μm images to identify different stellar components — bulge, disk, bar and/or nuclear point source. These 2D decompositions result in a final decomposition model for each galaxy with 1-4 components. Knowing the flux contained in each component, we can estimate the stellar mass of these structures. Our main findings up to now are the following: (1) more massive galaxies have higher bar-to-galaxy mass ratios, and (2) galaxies with a bulge component also present bars with a higher relative mass. We also find that bars are less present in lower mass galaxies ($M_\star < 10^9$ $M_\odot$, $\sim 38\%$). This is consistent with bar fraction studies that suggest that lower-mass galaxies are still acquiring and growing their bars. We are currently working to include the 4.5 μm band into our analysis, with GALFIT-M. With our 3.6 and 4.5 μm multi-band decomposition, we will be able to produce more robust stellar mass values for the bars, bringing us one step closer to understand how the stellar mass content in bars relates to other properties of the host galaxy.

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Modeling the chemistry of early Universe

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The chemistry of the early universe consisted mainly of simple atomic species and molecules composed of hydrogen and helium. Therefore, to understand the chemistry of the early Universe it is necessary to know the chemical processes that these species underwent. Also, the interaction with the CMB (Cosmic Microwave Background) is the best test to determine the evolution and abundance of the primordial species. We model the chemistry of the early Universe as a function of redshift using the astrochemistry package KROME. We focus in the $\mathbf{HeH^+}$ molecule because this molecule has a high dipole moment and is formed from the most abundant species, **H** and **He**. Also, its contribution to the optical opacity affects the CMB. In particular, we will explore the impact on the abundance of $\mathbf{HeH^+}$ of new rates for processes such as dissociative recombination and photodissociation. An accurate determination of the chemical composition of the primordial gas is important to understand the formation of the first stars in the universe.

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Mapping the Zoo of Rest-Frame galaxy SEDs using unsupervised machine learning

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Galaxy spectral energy distributions (SEDs) are well known for being a key factor of galaxy studies. When analyzing them, we can understand their properties and evolution. This work aims to look for alternative methods to analyse and visualise galaxy SEDs in a new manner by applying machine learning techniques. We implement unsupervised machine learning methods to order the zoo of synthetic single stellar population (SSP) of galaxy SEDs into a self-organizing map (SOM). The catalogue of synthetic SSP is generated using Flexible Stellar Population Synthesis (FSPS), where the galaxies are sampled at a fixed redshift of $z = 0.496$ with metallicities in range of $[-0.5, 0.2]$ in $\log(Z/Z_\odot)$. To achieve this, we build a compressed representation for each galaxy SED by implementing an autoencoder algorithm, which is used as the input for the SOM. As galaxy SEDs are grouped by similarity, they will be assigned to a particular category (or node), where neighbouring nodes represent similar spectra. Finally, we prove that this implementation is an efficient method to derive physical properties of galaxies, providing insights and techniques that will be useful for photometric redshifts and more generally to build a model of the galaxy population useful for future cosmological galaxy surveys.

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Unveiling intermediate redshift galaxy clusters within the next generation Fornax survey

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The Next Generation Fornax Survey (NGFS) features very deep stacks of images from visible (DECam u, g, i) to infrared (VIRCAM J, Ks) wavelengths with unprecedented photometric calibration standards. In this work, we present the first results of the ongoing effort to study the clusters in this field, going beyond the local universe. So far, our methodology for detecting clusters is comprised in a four-step pipeline: meticulous photometric analysis, photometric redshift calculation using Bayesian Photometric Z (BPZ; Benitez, N. et al 2004), cluster detection using PZWav (Gonzalez, A. 2014), and estimation of galaxy membership probabilities. As to be expected, our preliminary results in the first of seven tiles ($\lesssim$3 sq. deg. per tile) reveal an array of structures including voids and filaments, visualized using Voronoi Tessellations. Due to the gaps in the spectral coverage, between the challenges we face there are photometric redshift degeneracies, and thus, redshift deserts. Despite this, for the first tile we detect 37 clusters with 5-σ confidence (20 being at z>0.9). Binning in redshift space, we present color magnitude diagrams with clear red-sequence/blue-clouds and study the trend for galaxies within and out of clusters. Although the coverage of NGFS is much smaller than other surveys, it reaches higher redshift, potentially opening for empirical conclusions to be drawn in this window to the universe regarding galaxy evolution.

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Abundance of PBHs from optical and X-ray quasar microlensing observations: Constraints on the dark matter fraction

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The quasar microlensing effect allows us to estimate the mass and abundance of any kind of compact object in the lens galaxies, being sensitive to both, baryonic and dark matter (DM) distributions. Recent results of black hole mergers from the gravitational wave experiments LIGO/Virgo, raised again the interest in studying other astrophysical candidates to be part of the elusive DM nature. One of the possible candidates are the hypothetical Primordial Black Holes (PBHs), which have been extensively studied by the community over the last years. In this work, I present the results of comparing optical and X-ray observations of differential microlensing measurements of image pairs for a sample of lensed quasar systems, with computed microlensing magnification maps through a Bayesian analysis to constrain their abundances in the lens galaxies. To do this, we perform simulations of a mixed population of PBHs of different masses and stars (of constant mass $\sim 0.2-0.3 M_{\odot}$) exploring different relative fractions of both objects, plus a smooth matter component. As a result, for the mass range explored in this work, ranging from planetary to intermediate-mass PBHs ($\sim 10^{-3} M_{\odot} - 60 M_{\odot}$), we provide new upper limits for the estimated fraction of the DM in form of PBHs and set the most complete coverage of this area according to other microlensing studies.

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PostNewtonian dark matter halos

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In this contribution, we are interested in enforcing results reported in other works, where the main statement is that the general relativity formalism is not necessary to describe the physics of the halo around spiral galaxies. Then, an inter-median formalism between the classical Newtonian and the relativistic Tolman Oppenheimer Volkoff ones is used to model a halo filled with perfect fluid and equation of state obtained for the universal rotation curves of spiral galaxies. In order to keep the hydrostatic equilibrium the dark matter should have a nonzero pressure to compensate for the gravitational force of the mass contends in the halo. Then a state equation is demanded to accomplish this requirement and completes the set of space-time nonlinear gravitation field equations obtained from general relativity. The fact that the increment of the central pressure is not enough to support the increment of the gravitational attraction produced by the increment of the mass as seen in the mass-radius relation. The mass reaches a maximum, and after that it starts to fall to reach a minimum. Then, the mass increases again to reach a second maximum and decreases again. The curve starts with large radii and small masses and continues to large masses and small radii. The stable configurations are to the right of the maximums and the unstable ones to the left. As is common, in various mass-radio relations, for large values of the central pressure the curves start to entangle. The post-Newtonian model coincides with the relativistic TOV model so to model galactic halos the Newtonian approximation is sufficient and is not necessarily a relativistic formalism, as seen in the mass-radius and mass-pressure curves.

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Probing the formation histories of Nuclear Star Clusters in the Fornax Galaxy Cluster using UVIT

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The correlations between nuclear star clusters (NSCs) and their host galaxy indicate a fundamental connection between the formation of NSCs and their parent galaxy. A recent study by the Next Generation Fornax Survey (NGFS; Ordenes-Briceño et al. 2018) shows the presence of relatively massive nuclei in the faint dwarf at lower galaxy mass regime $\log(M_{\rm gal}/M_{\odot}) < 9.5$, which could be due to recent or ongoing star formation activity that contributes to an earlier build-up of nuclei relative to the rest of the galaxy. The NUV-optical-NIR colour-colour diagram also indicates the presence of young stellar populations (< 2 Gyr). Extending the SED coverage beyond the Balmer break to FUV allows us to determine the age and mass fraction of these young stellar components more accurately by combining data from NGFS. We obtained FUV data of two massive NSCs from the Ultra-Violet Imaging Telescope (UVIT) onboard AstroSat. We detect the most massive one above three sigma of the background fluctuation.

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