Unveiling the Universe with SHARP: a spectrgraph proposal for MORFEO@ELT

Abstracts

Speaker: Lorenzo Amati - Istituto Nazionale di Astrofisica (INAF)

Talk: The great synergy between SHARP and the THESEUS space mission

Schedule: *2nd October 2024, 09.30-09.50*

Abstract:

The Transient High-Energy Sky and Early Universe Surveyor (THESEUS) is a mission concept developed by a large European collaboration under study by ESA since2018 and currently one of the three candidate M7 mission for a launch in mid '30s. THESEUS aims at fully exploiting Gamma-Ray Bursts for investigating the early Universe and as key phenomena for multi-messenger astrophysics. In particular, By providing an unprecedented combination ofX-/gamma-ray monitors, on-board IR telescope and spacecraft autonomous fast slewing capabilities,THESEUS will be a wonderful machine

for the detection, multi-wavelength characterization and redshift measurement of any kind of GRBs and many classes of X-ray transients, including high-redshift GRBs for cosmology (pop-III stars, cosmic reionization, SFR and metallicity evolution up to the "cosmic dawn") and electromagnetic counterparts to sources of gravitational waves. THESEUS will also provide breakthrough measurements of GRB prompt and afterglow emission, as well as the detection and multi-wavelength characterization of many classes of high-energy transients. In all these s respects, THESEUS will thus provide an ideal synergy with the very large astronomical facilities of the future working in the e.m. (e.g., ELT, CTA, SKA, Athena) and multi-messenger (e.g., Einstein Telescope, Cosmic

Explorer, km3NET). Of particular relevance, especially for the exploration of the early Universe, will be the synergy with ELT, for which the SHARP spectrograph will play a key role by enabling both THESEUS and ELT to fully exploit their great potentialities in the study of primordial galaxies, first stars, IGM and cosmic re-ionization.

Speaker: Carmelo Arcidiacono - Istituto Nazionale di Astrofisica (INAF)
Talk: Adaptive Optics for the Extremely Large Telescope: Overcoming PSF Challenges with MORFEO
Schedule: *2nd October 2024, 10.10-10.30*
Abstract:
Adaptive optics (AO) has revolutionised ground-based optical and near-infrared astronomy by improving the point spread function (PSF) and enhancing both spatial resolution and sensitivity. MORFEO, the multi-conjugate AO module for the Extremely Large Telescope (ELT), further advances these capabilities by providing diffraction-limited performance over a wide field of view.
However, observational challenges persist due to the time-varying nature of the PSF, driven by atmospheric turbulence. In fields with limited bright point sources, typical at high galactic latitudes, PSF reconstruction remains difficult, complicating accurate data analysis. MORFEO mitigates these issues by using six laser guide stars and three natural guide stars, though calibration in sparse-star regions remains challenging. Furthermore, the scarcity of natural guide stars for the AO also limits PSF spatial uniformity. Observing strategies must also account for spectral resolution, sensitivity, and calibration stability. Ongoing research into improved calibration techniques and PSF modelling will aid MORFEO's upcoming challenges.

Speaker: Susanna Bisogni

Talk: Unveiling the Cosmic Dawn: looking for extended Lyman-alpha nebulae in an Universe younger than 600 Myr

Schedule: *2nd October 2024, 12.00-12.20*

Abstract:

The existence of luminous quasars just a few hundred million years after the Big Bang challenges our understanding of both black hole growth and galaxy formation and evolution. These objects harbour supermassive black holes exceeding a billion solar masses (M_bh > 10^9 M_sun) by redshift z~6, powered by extreme gas accretion. At the same time, their host galaxies are also undergoing intense star formation, consuming gas at the rate of hundreds of solar masses per year.

Characterising the circumgalactic medium (CGM) and intergalactic medium (IGM) surrounding high-redshift quasars becomes an essential tool to understand the conditions that enable the rapid formation and evolution of these extreme sources.

While in the last decades spatially resolved observations in the optical band have targeted Lyman-alpha nebulae surrounding z~2-6 quasars, current limitations hamper observations of high-z (z>8) quasars that will be discovered by Euclid/Roman/LSST.

Despite the large fraction of neutral hydrogen at the epoch of reionisation, in the last decade several surprising Lyα detections have been obtained from sources deep in the epoch of reionisation.

The unprecedented collecting area of ELT, resolution and wavelength coverage of SHARP, specifically VESPER, will enable us to map z>9 Lyman alpha emission down to the structures of size ~150 pc, while simultaneously capturing their large-scale structure up to 100 kpc for the first time at this redshifts, enabling exploration of quasars and galaxies formation and evolution deep in the epoch of reionisation.

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Speaker: Marco Castellano - Istituto Nazionale di Astrofisica (INAF)
Talk: Leveraging on JWST observations to plan high-resolution ELT spectroscopy of early galaxies
Schedule: *2nd October 2024, 12.20-12.40*
Abstract:
In this talk I will discuss perspectives for the investigations of galaxies at cosmic dawn using SHARP observations at high spatial and spectral resolution. I will describe results from the GLASS-JWST survey and from its follow-up spectroscopic Cycle 2 campaign that led to the discovery and spectroscopic confirmation of a puzzling high number density of bright galaxies 300-500 Myr after the Big Bang. I will present the deep, high-SNR NIRSpec observations which confirmed the redshift of a bright, high-ionizing object at z=12.3 and a high number of bright z~10 galaxies with several emission and absorption features detected at low resolution. These NIRSpec data enable the definition of science cases for the investigation of the first phases of galaxy assembly with SHARP@ELT, as well as the evaluation of the performances of ELT observations of bright galaxies at the cosmic frontier.
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Speaker: Avinash Chandrakumar - Instituto Nacional de Astrofísica, Óptica y Electrónica

Talk: Resolved Stellar Populations Using NIRCam and Implications for MORFEO@ELT

Schedule: *1st October 2024, 16.30-16.50*

Abstract:

The James Webb Space Telescope (JWST) has revolutionized our understanding of stellar populations in nearby galaxies, particularly through its NIRCam and MIRI instruments. Our study leverages JWST-NIRCam data to investigate resolved stellar populations and anticipates the impact of the upcoming Extremely Large Telescope (ELT). Using JWST-NIRCam color-magnitude diagrams (CMDs), we identified a stellar-metallicity gradient radially decreasing from the galaxy center in the nearby late-type disk galaxy, NGC 628, by analyzing stars in the Tip of the Red Giant Branch (TRGB). Additionally, we mapped the distribution of Carbon stars in the disk. While upcoming JWST-NIRSpec observations will allow for spectroscopic metallicity measurements of TRGB stars, crowding will limit these studies to the galaxy's outer regions due to JWST's resolution constraints. This work demonstrates how photometry using ELT and spectroscopy with the proposed SHARP instrument will enhance resolved-stellar population spectroscopic studies, building on JWST-NIRCam results.

Speaker: Elena Dalla Bontà - Università degli Studi di Padova

Talk: Dynamical mass measurements of supermassive black holes in quiescent galaxies and properties of galactic nuclei

Schedule: *1st October 2024, 11.30-11.50*

Abstract:

It is generally accepted that the evolution of galaxies is closely entwined with their nuclear properties and much attention has focused on the study of the central massive objects which can be constituted of either a supermassive black hole (SBH) or nuclear star cluster (NC).

NCs are present in 70% of low- and intermediate-luminosity galaxies. SBHs and NCs are not mutually exclusive and thus can coexist in some galaxies. Determination of their demography and scaling relations between their masses (or the sum of their masses) and larger galaxy properties, such as the stellar velocity dispersion, the total mass or luminosity, can provide important clues on how CMOs form and grow with their hosts. NCs may be the precursors of massive black holes in galaxy nuclei besides NCs and SBHs seem not to form a single family of CMOs since they do not obey the same scaling relations.

Nevertheless, to definitely unveil the link between SBHs and NCs and their origin, it is necessary constraining their masses in a statistically adequate number of galaxies where they coexist, not in an independent way but using a single modeling, so as to obtain more reliable and secure results.

The high resolution of VESPER@SHARP will allow to determine dynamical measurements of the SBHs and NCs by modeling the ionized gas and/or stellar kinematics.

Speaker: Matteo Fossati - Istituto Nazionale di Astrofisica (INAF)
Talk: The co-evolution of galaxies and their CGM: a SHARP perspective
Schedule: *2nd October 2024, 11.00-11.20*
Abstract:
It has long been known that the colorful variety of galaxies we see in the Universe is shaped by their cycle of baryons flowing in and out of the galactic systems. A significant amount of observations allowed us to investigate in great details the inner part of galaxy haloes, which are dominated by stars and ISM gas. At the same time, high resolution spectra of background quasars have revealed the statistical properties of the IGM, the gas the flows through the Cosmic Web. A key piece of this chain is the Circum Galactic Medium (CGM), i.e. the gas around galaxies. The properties of this critical gas phase, that feeds the ISM of galaxies required a combined effort to associate the gas in absorption, as seen by quasar sightlines, to the galaxy population, detected by large and pioneering multi-object spectroscopic efforts.
The advent of multiplexed Integral Field Spectrographs (e.g. MUSE) at the ESO Very Large Telescope, in synergy with grism spectroscopy from space has revolutionised our understanding of the CGM. These techniques, allow us to detect galaxies near quasar sightlines without any pre-selection. Large surveys, including the MUSE Analysis of Gas around Galaxies (MAGG) and the Muse Ultra Deep Field (MUDF) have uncovered that the properties of the CGM depend on the large scale galaxy environment and that strong hydrogen and metal absorbers are strongly associated to galaxies overdensities. I will present these results and their current limitations, both in sample size and redshift range probed. The next leap forward in this field is the study of the physical processes at play in the CGM. I will discuss how this goal can only be allowed by the ELT. The multiplexing, sensitivity and NIR coverage of the SHARP IFU, in synergy with deep imaging surveys from the Rubin and Euclid observatories, will allow unprecedented studies of the co-evolution of galaxies in different environments and their CGM uncovering the density, temperature and morphology of the gas that flows in and out of galaxies.

Speaker: Mario Guarcello

Talk: Beyond the Solar neighborhood. The SHARP view of young very massive stellar clusters.

Schedule: 1st *October 2024, 16.40-17.00*

Abstract:

Star and planet formation, as well as their early evolution, are influenced by the surrounding environment. This feedback is primarily shaped by three factors: 1) the nearby population of massive stars, which dominate their surroundings through intense UV and X-ray radiation emissions and intense stellar winds; 2) the stellar density, which determines the intensity of gravitational interactions between stars within young clusters; and 3) the metallicity, which is believed to play a key role in shaping outcomes of the star formation process, such as the initial mass function (IMF) and the dispersal of protoplanetary disks.To properly investigate these processes, it is essential to study young stellar clusters with masses greater than or equal to 10000 solar masses, or those with low metallicity. As such clusters are absent in the Solar neighborhood, it is necessary to observe distant, massive, or low-metallicity clusters using instruments capable of resolving their highly crowded stellar fields and penetrating several magnitudes of extinction. The Extremely Large Telescope (ELT) will be a game changer in this field due to its unprecedented capabilities. Specifically, MORFEO/SHARP will enable us to unveil the physical properties of stars in these distant star-forming regions, along with their protoplanetary disks, down to low masses, providing a comprehensive understanding of star formation and early stellar evolution in massive and low-metallicity environments.

Speaker: Enrichetta Iodice - Istituto Nazionale di Astrofisica (INAF)

Talk: Unveiling the structure of low-surface brightness galaxies with SHARP

Schedule: *1st October 2024, 12.00-12.20*

Abstract:

In this talk I would like to present the study of stellar kinematics and stellar populations for an extreme class of objects, the ultra-diffuse galaxies (UDGs), as a possible science case for SHARP.

To date, the confirmation of the LCDM cosmological model relies on our ability to find the baryonic counterparts of the predicted low-mass DM halos, which means deriving a complete census of the faintest, less massive stellar systems such as dwarf galaxies. In this context, the UDGs have a special role, being the extreme LSB tail of the size-luminosity distribution of dwarf galaxies. UDGs are empirically defined to be faint (μ0,g≥24 mag/arcsec^2) and diffuse (Re≥1.5kpc) objects, with stellar masses similar to dwarf galaxies (van Dokkum+2015). Since 2015, the interest in the UDGs universe has grown considerable attention, and several observational campaigns have been carried out to obtain deep images, mapping different environments, which have provided large samples of LSB galaxies, including UDGs (see Lim+2020; Marleau+2021; La Marca+2022a; Zaritsky+2022 and reference therein). Due to the LSB nature, getting spectroscopic data for UDGs is challenging. To date, compared to the availability of the deep images, we still lack statistically significant samples of UDGs with spectroscopy. However, the new spectroscopic surveys for UDGs suggest that they do not rotate and have a very low (**σ**~30 km/s) velocity dispersion (see Heesters+2022, Gannon+2023, Iodice+2023).These results pose serious doubts on the stability of these systems in dense environments. In particular, having such a low velocity dispersion and slow rotation velocity of stars, UDGs with a "normal" or low DM content might be disrupted by the tidal forces in the cluster core. Even if there is a plethora of formation scenarios for UDGs, which can reproduce all the observed morphologies, gas, and DM content, the stability of these systems has not been studied yet. On the observational side, the majority of detected UDGs are available in the local universe (z<0.05), therefore it is still unknown if the number density of UDGs in groups and clusters increases with redshift, which might reconcile with a limited lifetime. In this context, with SHARP, we might address the structure of UDGs in high-redshift clusters, as spectroscopic follow-up studies of the improved detection at higher redshifts from the new deep imaging surveys, as Euclid, JWST, and Rubin-LSST.

Speaker: Manuela Lippi - Istituto Nazionale di Astrofisica (INAF)

Talk: Exploring small bodies and moons in the outer Solar System with SHARP

Schedule*: 30th September 2024, 15.40-16.00*

Abstract:

Understanding the chemistry of small bodies (e.g., comets, centaurs, or transneptunian objects) and icy moons (e.g., Enceladus and Europa) in the outer Solar System is an important objective in astrobiology, as it provides key insights into the origins and evolution of life on Earth and (presumably) on other planets.

Small bodies are generally considered among the least altered bodies from the solar system formation. While many studies suggest that our planet formed in a water-poor region of our protoplanetary disk, comets, centaurs, and transneptunian objects are mostly composed of water and organic ices, suggesting that they may have delivered essential molecules to our planet, so to set the beginning and evolution of life.

On the other hand, moons in the outer solar system are highly processed, but they also may provide the best possible circumstances for life development. For example, scientists predict the existence of saltwater oceans beneath Europa's icy shell, and clouds, showers, rivers, lakes, and seas of liquid hydrocarbons on Titan surface.

Because of their astrobiological significance, both small bodies and icy moons in the outer solar system are targets of some of the next generation space missions, as the ESA - Comet Interceptor, that it is supposed to be operative starting from 2029, and the NASA - Europa Clipper, that will reach this Jupiter's moon in 2030.

To provide the best support for these and other space missions, it is critical to survey these objects from the ground as well.

Here, we will demonstrate the observing capabilities of SHARP@ELT applied in this context, showing how the sensitivity of this instrument combined with the MORFEO AO system will allow the deep study of the composition of small bodies as well as the investigation with unprecedented details of the surfaces and atmospheres of the moons in the outer Solar System.

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Speaker: Marcella Longhetti

Talk: Quiescent galaxies at cosmic noon: from individual element abundances to star formation histories

Schedule: *1st October 2024, 10.20-10.40*

Abstract:

We propose to leverage the enormous sensitivity achievable with SHARP/NEXUS coupled with MORFEO to study the chemical abundances in quiescent galaxies at z=2-3.

The metal content of galaxies (both the gaseous one and the stellar one) are the results of many interplaying mechanisms, such as gas inflow and outflow, star formation efficiency and assembling/merger processes. In particular, the stellar metallicity keeps the imprint of the gas enrichment integrated over the star formation and assembly history of galaxies. Different elements originate from different stellar evolutionary phases and thus appear on different timescales. Therefore, the possibility to obtain specific abundances of individual elements characterizing the stellar content of galaxies at different epochs is a powerful tool for gaining insights into the mechanisms that have shaped galaxies as they appear today.

Individual element abundances can be derived from rest-frame medium resolution optical spectra at high SNR (i.e., SNR>30/Å). The high SNR required, combined with the wide wavelength range needed to perform this analysis, has limited studies of chemical abundances to galaxies at $z < 1$. The facilities currently planned for E-ELT will not allow to overcome this limitation because none of them offers the possibility to cover the spectral range needed for this type of study coupled with the efficiency levels required to obtain the necessary SNR within reasonable exposure times.

SHARP/NEXUS, thanks to access to MCAO of MORFEO and to the full nearIR range coverage, will provide a unique opportunity to probe the chemical enrichment histories of galaxies.

Speaker: Matteo Messa (and/or) Eros Vanzella

Talk: Probing parsec-scale star-formation, proto-Globulars and pristine star formation in the early Universe in lensed fields with MORFEO - MICADO+SHARP

Schedule: *2nd October 2024, 14.20-14.40*

Abstract:

The advent of an efficient wide-field integral field spectrograph on an 8-meter class telescope has revolutionized the study of the high redshift Universe, particularly in strongly lensed fields. Deep MUSE observations, conducted without any target preselection in these lensed fields and combined with space-based facilities like HST and JWST, have opened new avenues for the unprecedented identification of proto-globular clusters and very low metallicity star-forming complexes in the first gigayears after the Big Bang, approaching star formation in pristine conditions (Population III). These observations offer a glimpse of what ELT imaging and spectroscopy will achieve in non-lensed fields. What's next? ELT-MORFEO-MICADO and SHARP will enable another quantum leap, allowing us to peer at sub-parsec scale star formation in lensed fields, resolving stellar clusters with multiple resolution elements, identifying ultraviolet emission and absorption lines at cosmic reionization and beyond ($z>10-12$), and optical lines at cosmic noon. This will fully exploit the multiplexing capabilities of SHARP, which match the typical lensing cross section of galaxy clusters and the MICADO field of view. Specific showcases will be presented, such as the Sparkler globulars at $z=1.37$, the Cosmic Archipelago at $z=6.14$, and the Cosmic Gems at $z=10.2$.

Speaker: Marco Mirabile - Istituto Nazionale di Astrofisica (INAF)
Talk: SHARP(ening the) view of unresolved globular clusters in the local universe.
Schedule: *1st October 2024, 15.40-16.00*
Abstract:
Globular clusters (GCs) are valuable tools to study the formation and evolutionary history of galaxies: being old (t > 10 Gyr) and relatively simple stellar systems, they can be used to trace the processes that shaped galaxies within their host environment. In recent decades, constraints based on extragalactic GC studies have mostly come from multi-band imaging data, with only a few studies based on spectroscopy. This is mainly because observing GCs, even in the nearest galaxy clusters and groups, requires a prohibitive amount of telescope time. SHARP at ELT will have the potential to revolutionize this situation.
In this presentation, we will review the present knowledge on this topic, focusing on spectroscopic studies, including our recent experience with MUSE data of GCs in the Hydra-I galaxy cluster, and discuss the opportunities for SHARP.

Speaker: Luca Pasquini

Talk: VLT/I: Present and Future

Schedule: *1st October 2024, 09.30-10.00*

Abstract:

In spite of 25+ years of successful operations, the VLT/I infrastructure and instrumentation set is in continuous evolution, to keep the Paranal Observatory at the edge of astrophysical research, while ESO is building the giant ELT. I will present the current status of the Paranal Observatory, the ongoing instruments & infrastructure upgrades, and those in preliminary (phase A) study. The present VLT/I long-term strategy and future will be soon revised, with a process that will start in 2025.

Speaker: Linda Podio - INAF - Osservatorio Astrofisico di Arcetri
Talk: Star and planet formation in the Solar neighborhood and beyond with SHARP
Schedule: *30th September 2024, 15.20-15.40*
Abstract:
The formation of stars and planetary systems is one of the most complex processes in the Universe. Over the last decades, astronomers have studied extensively the star forming regions in the Solar neighborhood at short heliocentric distances (within 500 pc). These regions are made of a few tens to a few hundreds of stars. Nevertheless, the vast majority of stars form inside giant molecular clouds which dominate the star formation rate of the entire Galaxy.
The unprecedented observing capabilities of the ELT will soon allow us to sneak into the darkest interior of the most massive molecular clouds of the outer Galaxy and of the Magellanic Clouds. In particular, MORFEO-SHARP with its two facilities (Nexus and Vesper) will be able for the first time to spatially resolve the individual spectra of young stellar objects (YSOs). From the near-infrared spectra we will determine the physical properties of the newly formed stars (e.g., their mass, temperature, gravity and metallicity) as well as the rate of mass accretion and mass loss (from hydrogen recombination lines, H2 and CO ro-vibrational transitions and forbidden lines of e.g. [FeII]) in star forming regions never explored before. With SHARP we will be able to study the role of environmental effects, such as external photo-evaporation, stellar feedback, and metallicity on the formation of stars and planetary systems and to derive the initial mass function, the disk fraction, and the accretion/ejection properties of YSO in star forming regions very different from those of the Solar neighborhood.
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Speaker: Mari Polletta - Istituto Nazionale di Astrofisica (INAF)
Talk: Fueling and feedback mechanisms at the nodes of the cosmic web
Schedule: *2nd October 2024, 14.40-15.00*
Abstract:

The local and large-scale environments affect galaxy formation and evolution. Our goal is to investigate the connection between the location of a galaxy in the "cosmic web" of large-scale structure and its baryonic content. SHARP multiplexing capabilities will provide the 3D view of the galaxies at the nodes of cosmic filaments at 1.5<z<4 over spatial scales of 1 cMpc in a single pointing. Assembling clusters at these redshifts host spectacular activity: from strong star formation to quenching, and offer a privileged view of morphological transformation. NEXUS will provide quick and efficient identification and first characterization of the galaxy members in the protocluster core region (R200 goes from 1 to 0.4 cMpc from redshift 1.5 to 4; Chiang et al. 2017), as well as the cluster dynamics. VESPER will provide the gas kinematics (e.g., inflowing or outflowing gas), and will map the metallicity, the age and the activity level of the stellar component. These measurements will provide constraints on the fueling and feedback mechanisms that regulate the growth and the decline of the star formation activity in cluster galaxies. The targets of this program are the cores of galaxy protoclusters and high-redshift clusters at redshift 1.5<z<4. In particular, we will select high redshift clusters and protoclusters with ancillary data that include high resolution multi-band optical/near-infrared imaging, and sub-mm and mm observation of dust continuum and of molecular gas tracers. The availability of deep X-ray observations and wide-field Lyman-alpha and HI imaging will be also taken into account in the target selection. SHARP will enable a deep and densely-sampled infrared spectroscopic survey covering the core region of the selected targets to line flux limits of 10−18 erg/s/cm2/arcsec2 (in 1hr exposure) which correspond to Halpha- or [OII]-based SFRs that are 2.7dex below the main sequence of star formation. Halpha will be observable up to z~2.6 and [OII] at z>2.2 enabling a calibration of the two SFR tracers for sources at 2.2<z<2.6. The proposed program will be key to explore the early phases of environmental effects on galaxy formation and evolution as well as the beginning of structure formation.

Speaker: Fabio Rigamonti - Istituto Nazionale di Astrofisica (INAF)
Talk: Galactic dynamics at cosmic noon: a new era with ELT
Schedule: *1st October 2024, 15.20-15.40*
Abstract:

In the local Universe IFS surveys (e.g. MaNGA) have allowed the measurement of spatially resolved properties of galaxies. In particular, it is now possible to interpret simultaneously the galaxies' photometric and kinematic data (stellar l.o.s. velocity and velocity dispersion) by constructing full dynamical models of these systems. These models have been recently used (Rigamonti et al. 2022) to obtain unbiased decomposition (primarily bulge and disc) of galaxies on large IFS samples (i.e. MaNGA, Rigamonti et al. 2024). The dynamically estimated bulge and disc masses, radii, mass-to-light ratios, kinematics, and dark matter fractions of +10,000 galaxies led us to review the relative role of violent and secular processes in shaping galaxies discussing also the connection between morphological transformation and quenching.

High redshift photometry (Ferreira et al., 2023) and gas kinematics (Lelli et al. 2021 and Parlanti et al. 2024) suggest that a precursor of the Hubble sequence was already in place between redshift 2 and 6. This implies that an extension of dynamical models to high redshift could be extremely interesting and fruitful. Currently, measuring spatially resolved stellar properties (population and kinematics) at high redshift is challenging both because of the compact nature of galaxies and the required signal-to-noise. With the advent of ELT such issues will be resolved. By combining the ELT's high-resolution imaging with IFS observations from VESPER we aim to measure these properties at redshift above 2 pushing the frontier of galactic dynamical modeling and decomposition to the earliest cosmological times. We plan to measure the mass in galaxies' hot (spheroidal) and cold (disk) stellar components to understand the nature of low redshift bulge and disc precursors. Combining our decomposition approach with stellar population synthesis analysis we will determine the ages, metallicities, and star-formation properties of the identified components. Our dynamical modeling provides measurements of galaxies' dark matter content and stellar mass-to-light ratios. The latter if compared to those determined from stellar population analysis will help investigate possible evolutions in the IMF. Finally, by combining our measurement of galaxies' intrinsic kinematics with star-formation properties during the epoch of cosmic noon, we aim at a better assessment of the process of quenching connected with the galaxy morphological evolution.

Speaker: Paolo Saracco - INAF - Osservatorio Astronomico di Brera

Talk: SHARP - A Near-IR Multi-mode Spectrograph Conceived for the Multi-Conjugate Adaptive Optics Module MORFEO@ELT

Schedule: *30th September 2024, 11.30-12.00*

Abstract:

The world's largest aperture combined with state-of-the-art Adaptive Optics systems will enable the ELT to capture better data than the JWST in both sharpness and depth. Therefore, the spectrograph intended for the 2nd port of the Multi-Conjugate Adaptive Optics (MCAO) system MORFEO@ELT will be the most powerful instrument of the JWST era, revealing phenomena beyond the reach of others. SHARP (http://sharp.brera.inaf.it) is a concept study for a near-IR spectrograph for the 2nd port of MORFEO@ELT, intended for a future ESO's call for new instrumentation. Composed of a Multi-Object Spectrograph, NEXUS, and a multi-Integral Field Unit, VESPER, SHARP covers the wavelength range to 0.95-2.45 μ. Coupled with MCAO-assisted observations, it delivers unprecedented high angular (~30 mas) and spectral resolution, outperforming NIRSpec@JWST (100 mas). MORFEO-SHARP will allow us to study the nearby and the early Universe in unprecedented detail, resolving the first galaxies and the star forming regions within galaxies far back in cosmic time, and providing spectra of individual nearby young stellar objects. This presentation introduces the scientific rationale behind SHARP, showcasing its features.

Speaker: Matilde Signorini - Istituto Nazionale di Astrofisica (INAF)

Talk: Precision near-IR spectroscopy for understanding AGN physics and shed light on the H0 tension

Schedule: *1st October 2024, 14.40-15.00*

Abstract:

The broad-line region (BLR) holds the key to measuring supermassive black hole mass and understand the physics of active galactic nuclei (AGN). Typically unresolved, reverberation mapping (RM) of the Doppler-broadened emission lines has been used to determine its size through variability. While many optical RM campaigns have been successful, in the near-infrared the lack of sensitivity has hampered progress. As a consequence, the emission properties of the BLR in this regime, and its connections with the rest of the accretion disk and BLR emission remain not fully understood.

In this talk, at first I will discuss the main issues that affect this field and how SHARP can bring significant progress given its capability to enable percent-level precision on the emission line fluxes.

Then, I will describe how precision infrared RM can be used in synergy with spectroastrometry (the "SARM" method) to measure the absolute geometric distance of an AGN and, therefore, can be used as a completely calibration-free measurement of the Hubble constant H0. I will outline how the synergy of SHARP with the GRAVITY+ instrument at VLTI could shed light on one of the most relevant challenges of nowadays cosmology, the H0 tension.

Speaker: Crescenzo Tortora - Istituto Nazionale di Astrofisica (INAF)
Talk: Understanding the origin of the golden mass across cosmic history
Schedule: *1st October 2024, 11.10-11.30*
Abstract:
The total mass distribution within galaxies, encompassing both baryonic and non-baryonic mass, significantly impacts the baryonic cycle and star formation (SF). This influence operates directly through gas availability for SF and supernova (SN) and/or AGN feedback, and indirectly through the presence of a dark matter (DM) potential well that extends beyond baryonic matter.
The correlation between star formation efficiency (defined as the stellar mass to total galaxy mass ratio normalized by the cosmological baryon fraction) and stellar mass peaks at a characteristic stellar mass of 3 × 10^10 $M_\odot$, referred to as the "golden mass." At this threshold, various feedback mechanisms minimally affect SF. This critical mass scale also appears in other scaling relations involving color, star formation rate (SFR), color gradient, size, DM fraction, and mass density slope. What different processes shape the observed scaling relations, and to what extent? Why do scaling relations exhibit this characteristic mass scale, and how does it manifest? How do these relations and the characteristic mass vary with galaxy type and cosmic time?
I will discuss how, thanks to their capabilities, SHARP and ELT can provide answers to these open questions. In the mIFU mode, SHARP can measure spatially resolved stellar populations and dynamical maps for galaxies at z>1, determining stellar mass profiles, stellar population gradients, constraints on dynamical mass profiles, DM fraction, and total and DM matter density slopes in central galaxy regions. Reconstructing the scaling relations of these observables as a function of stellar mass for early- and late-type systems would allow us to trace these scaling relations and the emergence of the golden mass as a function of redshift, and to reconstruct the impact of galaxy processes (such as mergers, SN, and AGN feedback) by comparing them with cosmological simulations.

Speaker: Giustina Vietri

Talk: Unveiling the Cosmic Noon: 3D mapping of the AGN feedback in the bulk of the galaxy population

Schedule: *1st October 2024, 15.00-15.20*

Abstract:

To better understand the role of AGN-driven outflows as a mechanism for heating or sweeping up gas over distances comparable to the size of the galaxy in its evolution, and to explore their physical characteristics as a function of AGN and host galaxy properties, it is necessary to have a statistical sample of AGNs selected from a uniform sample of galaxies with a spectroscopic coverage of important rest-frame optical emission lines.

To determine the impact of the AGN-driven outflows have on their host galaxies, we need to derive mass and energy carried by the outflows, as well as correlations of these parameters with both AGN and host galaxy properties to reveal their effects on the galaxy population as a whole, and constrain the physical mechanisms driving the outflows. The availability of 3D data would enable the construction of resolved outflow properties maps to get instantaneous outflow rates along the entire FOV, without assuming outflow geometry, resulting in smaller uncertainties of these quantities than the methods applied for longslit spectroscopy.

We therefore aim to investigate the effect of AGNs in a sample of galaxies at the cosmic noon, $1.5 < z < 3.6$. Our sample will cover a wide range of stellar masses, $8 < \log(M_{star}/M_{sun}) < 11.5$, pushing 3D outflow studies into the dwarf regime on the main sequence and passive locus at high-mass, thanks to the flux limit achievable with SHARP/VESPER.

This project will cover [OII] up to z=3.6 and Hα up to z=2.6, which trace instantaneous star formation (<10 Myr), and [OIII] covering the entire selected redshift range, which is particularly important in tracing the NLR gas and ionized outflows around AGNs. We will not preselect AGNs but will identify them retrospectively using ancillary data of the selected sample (using rest-frame optical diagnostics and X-ray/MIR/etc. imaging datasets). The line flux limit of SHARP is $10-18$ erg/s/cm^2/arcsec^2 (in a 1-hour exposure with SNR=1), which corresponds to Hα- or [OII]-based SFRs on the main sequence for dwarf galaxies, and that are 2.5 dex below the main sequence of star formation at Mstar=1e10. By adopting a SNR of at least 3 we require 9hr exposure time on each galaxy (e.g. considering 3 bins of SFR and stellar mass, with 50 objects per bin —> 338 hrs).

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Speaker: Hai-Feng Wang - Università degli Studi di Padova

Talk: Milky Way Rotation curve, mass and Sagittarius Dwarf galaxy progress

Schedule: *1st October 2024, 16.50-17.10*

Abstract:

We apply a statistical deconvolution of the parallax errors based on Lucy's inversion method (LIM) to the Gaia DR3 sources to measure their 3D velocity components in the range of Galactocentric distances R between 8 and 30 kpc with their corresponding errors and rms values. The kinematic maps reconstructed with LIM up to around 30 kpc show that the Milky Way is characterized by asymmetrical motions with significant gradients in all velocity components. Furthermore, we determine the Galaxy rotation curve Vc(R) up to 28 kpc with the cylindrical Jeans equation assuming an axisymmetric gravitational potential. Then, We use the rotation curve from Gaia data release (DR) 3 to estimate the mass of the Milky Way. We consider an Einasto density profile to model the dark matter component. We extrapolate and obtain a dynamical mass M = 2.75 (+3.11/-0.48) × 10^11 solar mass at 112 kpc. This lower-mass Milky Way is consistent with the significant declining rotation curve, and can provide new insights into our Galaxy and halo inhabitants. Finally, base on the mass, we attempt to reconstruct the Sgr core morphology and kinematics on the basis of a model that has already successfully reproduced the Sgr stream. Here we use a very high resolution model that almost resolves individual stars in the Sgr core. It reproduces most of the observed morphology and kinematic properties, without specific fine tuning. In the future, ELT will be super helpful for us to unveil more secrets of the Milky way and Dwarfs.

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Speaker: Stefano Zibetti and Anna Gallazzi

Talk: The Emergence of Spiral Galaxy Structure at Cosmic Noon

Schedule: *1st October 2024, 12.20-12.40*

Abstract:

Tracing the formation of structural components in spiral and disk-dominated galaxies (bulges, disks, spiral arms, and bars) in conjunction with the fossil record of star formation and chemical enrichment histories provides crucial insights into the evolutionary processes of galaxies at early cosmic times. These probes are sensitive to both secular/internal and externally driven events such as mergers and interactions.

The primary objective is to characterize galaxy structures from both dynamical and stellar population perspectives through 3D spectroscopic analysis of the stellar continuum in galaxies at cosmic noon and beyond. Key questions include:

· What are the kinematic signatures of emerging spiral structures and bulges?

· How does the presence of spiral structure correlate with star formation history and metallicity?

· Can we detect evidence of secular evolution or minor mergers driving spiral formation?

The NIR coverage of SHARP, coupled with the high spatial resolution and sensitivity achievable with MORFEO at ELT, presents a unique opportunity to study the kinematics and fossil record of bulges, bars, and disks/spiral arms in relatively low-mass star-forming galaxies at z~1.5-3. The mass range $9.5 < \log(M^*/M_\odot) < 10$ is an ideal target, just below the threshold where passive/early-type systems begin to dominate.

SHARP's key advantages over current or planned NIR facilities include:

- Superior spatial resolution (3x better than JWST)
- Multiplexing capability (compared to MICADO and HARMONI)
- Extended wavelength coverage up to 2.4 μm (surpassing MOSAIC)

Despite a more limited FoV compared to JWST NIRSpec MOS, the number density of galaxies with $9.5 < \log(M^*/M_\odot) < 10$, corresponding roughly to H=24 at z=2, should provide a few targets per pointing, exploiting the multiplexing of NEXUS and VESPER.

Using the ETC developed by Paolo Franzetti, in 4 hours of integration, we can achieve SNR~15 per observed Å (i.e., ~25 per rest-frame Å at z~2) for H_AB=24 (point-like source). This magnitude corresponds to galaxies of $\log(M^*/M_\odot) \sim 9.5$-10 at z~2. We anticipate <~10 H<24 galaxies at z>1.5 in the NEXUS FoV, and a few in the VESPER FoV. Multiple pointings will be necessary to compile a sample of several tens to 100 objects.

The NIR coverage enables detection of Hα up to z~2.6 and Mg absorption features up to z~3.6, allowing for comprehensive studies of both kinematics and stellar populations across a significant redshift range.