EMIR@GTC: Abstracts and Talks

Below is the list of science talks for EMIR@GTC meeting in Cadiz.

The GOYA survey with EMIR & GTC **Mercedes Prieto**

GOYA is a survey of the high-redshift universe using, in guaranteed time, the EMIR NIR multi-object spectrograph on the 10-m Gran Telescopio Canarias (GTC). The GOYA survey is an assembly of several scientific projects to be conducted simultaneously for the study of key questions on cosmological galaxy evolution including the star-formation history of low-mass star-forming galaxies; characterization of most massive galaxies, their mass assembly, stellar populations and IMF; and the identification and characterization of the sources of cosmic reionization. The main characteristics of the survey will be presented as well as the coordination between the different scientific projects included in GOYA.

The GOYA survey. MAGINASTE: Science case for z~1 massive galaxies **Alexandre Vazdekis**

There is a mounting evidence suggesting that the Initial Mass Function (IMF) is no longer universal, at least for the innermost regions of massive Early-Type Galaxies (ETGs). Detailed spectroscopic stellar population studies as well as dynamical and gravitational lensing analyses find that more massive ETGs host an increased fraction of dwarf stars with M<0.5Msun in comparison to the Milky Way. However, such a bottom-heavy IMF prevents reaching the high metallicity regime (above solar) commonly found for these galaxies. This implies that the IMF should have also varied over cosmic time evolving from an early short-lived top-heavy IMF phase to the current bottom-heavy phase. Within this two-phase galaxy formation scenario, it is expected that the more massive the galaxy is the more pronounced this IMF change is and, also, the shorter the period in which this transition takes place. We propose obtaining high quality (S/N>50) spectra of galaxies at z~1 of a well selected sample of intermediate-to-high mass ETGs to test this scenario from the GOYA Survey and with EMIR-GTC. The use of a well selected set of IMF-sensitive indices with newly developed state-of-the-art E-MILES stellar population models will allow us to constrain whether the IMF has changed with respect to their local galaxies counterparts.

The first generation of galaxies with EMIR **Roser Pello**

This talk presents the state of the art regarding the spectroscopic identification and study of star-forming galaxies at z>6, and the expected contribution of GOYA with EMIR/GTC to this major topic in observational cosmology. This population of galaxies is supposed to make a substantial contribution to cosmic reionization. However, present results mostly rely on photometric considerations, whereas a robust estimate of the ionizing emissivity and its evolution with redshift requires a good knowledge on the physical parameters of star-forming galaxies, which in turn relies on detailed spectroscopy coupled with multi-wavelength studies. Current results on the abundance of high-z star-forming galaxies, derived from deep surveys in lensing and blank fields, will be presented and discussed. Spectroscopy is compulsory to build a robust/reference sample from photometric candidates. It is also needed to understand the nature of (extreme) mid-z interlopers presently found in deep surveys. EMIR/GTC is expected to introduce a substantial progress in this area.

Star Formation and Stellar mass assembly of low-mass star-forming galaxies at intermediate redshifts — **Jesús Gallego**

Chemical enrichment and star formation processes play a major role in galaxy evolution and dwarf galaxies are ideal to study these phenomena.
We aim at studying low-mass field galaxies, the most poorly known, but abundant systems. Their intrinsic low luminosities and small angular sizes make them very difficult to observe. Our major goal is to investigate when has occurred their bulk of star formation and mass assembly.

Spectroscopy of 4 bright Lyman alpha sources — **José Miguel Rodríguez Espinosa**

We propose to explore with EMIR, through deep NIR spectroscopic follow-up, a unique, carefully selected sample of the 4 most luminous (~ 1043.5−44.0 erg s−1) Lyman-α (Lyα) emitters ever found into the epoch of re-ionisation (z ~ 7 − 8): CR7, MASOSA, VR7 and S-CR7. We have discovered those through our own very wide field narrow-band imaging with the Subaru telescope (e.g. Sobral+2015; Matthee+2017), and our HST (21 orbits) and ALMA (10 hours) follow-up is on-going, revealing that these sources have multiple clumps/components (~ 3 each) and low metallicities (~ 0.01 − 0.1Z⊙). With EMIR, we aim to push our knowledge forward by detecting or obtaining the most stringent constraints on important rest-frame UV lines such as Civ, Ciii, Hii, Niv, Nv, and to directly compare those with Lyα. We will interpret these with our extensive, just completed, cloudy modelling exploring a wide range of ionising sources and state-of-the-art stellar population synthesis models. Our observations will allow some of the most stringent tests on the nature of early stellar populations, their metallicity and their role in cosmic re-ionisation, and to make clear predictions for the rest-frame optical lines that will be seen with JWST.

MAGINASTE, galaxias masivas a z=1-4 — **Marc Balcells Comas**

MAGINASTE es uno de los *surveys* coordinados dentro de GOYA. El objetivo es caracterizar galaxias masivas en z=1-4 a partir de sus dispersiones de velocidad, sus edades y metalicidades. Para un subgrupo de galaxias más brillantes, en z=1, buscaremos obtener diagnósticos sobre la IMF. El proyecto obtuvo datos con EMIR en el periodo de verificación científica. Describiré las características de los datos y nuestra experiencia en la adquisición y procesado de los datos.

Science verification and commissioning proposals: Starbursts — **Casiana Muñoz-Tuñón**

I will discuss two cases for EMIR for studying starbursts galaxies: the first one will dealt with star-forming galaxies in Clusters up to z=2; and the second one to study particular cases from COSMOS/GOODsN/CANDELS surveys of galaxies at z=6.

Age of passively evolving galaxies at high-redshift — **Nieves Castro**

The goal of this project with GTC/EMIR is to obtain near infrared spectra of candidate very massive old passive evolution galaxies with 2.5<z<3.0. The goal is confirming spectroscopically our findings based on photometric data alone: their redshifts and their ages >1.4 Gyr when the Universe was relatively young. These results will be relevant to constrain the possible scenarios of galaxy formation and cosmological models. Among samples of galaxies with deep photometry in the optical and near and mid- infrared, we have searched for extremely red galaxies in the XMM-LSS field at zphot > 2.5 with photometric features of old passive-evolving galaxies without dust. In EMIR-H grism, the covered range is 15200-17700 Å, which corresponds at rest to 4340-5060 Å for z = 2.50 and 3800-4425 Å for z = 3.00. In particular, this range includes age-sensitive indices: CaII H and K lines (3933 and 3970 Å), Balmer break (4000 Å) and Balmer lines [Hδ (4102 Å), Hγ (4340 Å), Hβ (4861 Å)].

Neutron-capture element emission lines in the EMIR spectra of three PNe — **Simone Madonna**

The study of the s-process in AGB stars through nebular spectroscopy is a recent field of astrophysics, that in the last 16 years has undergone a remarkable growth. In 2001, neutron(n)-capture element abundances had been determined in just three PNe. That number now exceeds 100 for Galactic planetary nebulae (PNe) and 10 for extragalactic PNe. Over the years, the discovery of new n-capture element emission lines in the optical and near-infrared (NIR) spectra of PNe has been crucial in the understanding of physical and nucleosynthesis processes in AGB stars, as well as in the development of atomic physics. The synergistic relation between observations, atomic data computations and numerical modeling, has allowed the development of new Ionization Correction Factors (ICFs) for Kr and Se, and new ICFs will be soon available for other neutron-capture elements. Furthermore, detections of new faint emission lines of n-capture ions are a key ingredient to test the veracity of the new atomic data calculated for different ions such as Se2+, Kr5+ and Rb3+. In this work we present the discovery of the faint [Br V] 1.6429 um and [Te III] 2.1020 um emission lines in the planetary nebulae M1-11 and NGC 7027 observed with EMIR, as well as other n-capture element emission lines in these PNe and in NGC 2440; these new detections have allowed us to compute s-process enrichments in these objects.

EMIR observations of Mercer 23 — **Paco Najarro**

We will report on our observing program of massive stars in the Mercer 23 cluster.

How do massive stars form? Finding targets for MIRADAS — **Amparo Marco**

We have obtained observations with the WHT (LIRIS) and we were able to get images for a hundred different fields in the J, H and KS bands. We could identify the massive star population associated with the HII regions using our images and photometry and now, in the second phase, we want to confirm the nature of some of them using spectroscopy. For the first phase, we have selected those stars that are apparently isolated and we request infrared spectra to confirm that they are the ionizing stars of the HII regions. With the approximate spectral types that we will derive from these observations, we will estimate their intrinsic brightness and then use our LIRIS photometry to verify if any other massive star could be present in the HII region.
This survey will provide a wealth of information on a completely new sample of previously unknown massive stars and, besides, will be extremely useful for the design of the future observations with MIRADAS

The relic galaxy NGC 1277 — **Mike Beasley**

Under the two-phase galaxy formation scenario, the core of massive galaxies is formed in the monolithic-like phase at high redshift (z >2), followed by an accretion phase where new material is added to the outskirts through a series of mergers. Due to the stochastic nature of mergers, we expect a small fraction of primitive massive cores survive untouched over cosmic time. These galaxies are called ”relic galaxies” and NGC 1277 is one of them. Using long-slit spectroscopic observation taken with EMIR and also recently extended E-MILES stellar population models which are computed on the basis of empirical stellar spectra, we study the stellar population gradients of NGC 1277 out to an effective radius, as they were in the primitive Universe. The near-infrared (NIR) spectral range of EMIR is dominated by cool stars, hence providing us with various spectral indices which are identified in the E-MILES models. So this range allows us to detect young stellar components and estimate key abundance element ratios. Moreover, the NIR is particularly useful for probing the radial variations of the initial mass function and investigating its main driver in massive galaxies.

GALEP, a Galactic project with EMIR **Paco Garzón**

I will outline the GALEP project, an observational programme to be executed with EMIR@GTC. The aim is to obtain near IR spectra of thousands of inner Galaxy objects. The sources are selected based on their position in the near IR colour magnitude diagram and include objects from the disc, bar bulb and central ring. The aim is to obtain a precise spectral classification in order to understand the reddest part of the diagram which to date is poorly understood. Without this information there remain ambiguities in interpreting the inner structures of the Galaxy. This project will measure and classify a significant fraction of the sources in specific areas in a way the will avoid the a priori hypotheses for their interpretation. The areas will be spread over a wide area along the plane. This project will add a good complement to the ongoing GAIA-ESO Survey (GES).

Obscured massive stars in the Milky Way with EMIR **Artemio Herrero**

MASGOMAS (MAssive Stars in Galactic Obscured MAssive clusterS) is a project aimed at finding extincted clusters and associations of young massive stars, particularly (but not only) OB types. A spectrograph like EMIR attached to a telescope like GTC is required to observe the obscured stars at infrared wavelengths with enough S/N to obtain their stellar parameters, study their physics and evolutionary status and confirm or reject the nature of the possible clusters. In this talk we briefly review the advances in the project and the first steps with EMIR.

Transits and occultations of exoplanets with EMIR **Roi Alonso**

When an exoplanet with an atmosphere transits its host star, its radius is wavelength-dependent, and this can reveal the main characteristics of the atmosphere at the terminator of the planet. When it goes behind the star, the depth of the eclipses is modelled by a combination of reflected and thermally emitted light, which is an average of the day-side of the planet. Our group has been using GTC/OSIRIS in the last years to obtain transmission spectra of several hot-Jupiters, and the arrival of EMIR opens an opportunity to expand the study of the atmospheres of these objects to the near-IR. We will describe the two main types of observations that we are pursuing, and show some preliminary results obtained in the science verification of EMIR.