RevMexAA (Serie de Conferencias), **42**, 70–72 (2013)

THE OTELO PROJECT

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RESUMEN

El Proyecto OTELO es el cartografiado extragaláctico que se desarrolla mediante los filtros sintonizables del instrumento OSIRIS del GTC. Ya está proporcionando el cartografiado más profundo de galaxias en emisión que existe, hasta un desplazamiento al rojo de 7. En esta contribución, se presenta el estado del cartografiado, así como algunos resultados preliminares obtenidos.

ABSTRACT

The OTELO Project is an extragalactic survey under way using the tunable filters of the instrument OSIRIS at the GTC. OTELO is already providing the deepest emission line survey of the universe up to a redshift 7. In this contribution, the status of the survey and the first preliminary results obtained will be presented.

Key Words: galaxies: abundances — galaxies: evolution — galaxies: high-redshift — methods: observational — surveys — techniques: imaging spectroscopy

1. INTRODUCTION

OTELO is an emission line survey using the Tunable Filters (TF) of the instrument OSIRIS at the 10.4 m GTC telescope. The OSIRIS TFs allow obtaining narrow band images anywhere within the OSIRIS wavelength range, from 365 nm to 930 nm, and with full widths at half maximum (FWHM) ranging from 1.2 nm to 4 nm, depending on the wavelength. Both the central wavelength and the FWHM can be tuned in tens of milliseconds. These characteristics allow performing narrow band tomography over a wavelength range of interest. In this technique, a set of images of the same field is obtained at different contiguous wavelengths scanning the desired wavelength interval. Aperture photometry allows constructing low resolution spectra of the targets detected in the field, and identifying emission lines. For each emission line, different redshift ranges are mapped. Then, the emission line targets detected can range from low redshift galaxies emitting in Hα, to Lyman-α emitters at high redshift. The FWHM and the sampling interval drives the spectral resolution and photometric accuracy of the 3D spectra, while the exposure time drives the minimum luminosity detectable at each redshift range. Then, different volumes of universe are scanned at well defined depths.

OTELO will scan a wavelength interval defined by a window within the OH emission line forest, centered at 920 nm, and spanning 21 nm. The goal is to cover a total area of 0.1 square degrees, distributed in different pointings to the fields GOODS-N, Extended GROTH Strip (EGS), SXDS and selected areas of ACS/COSMOS, to control cosmic statistics. A FWHM of 1.2 nm and a sampling interval of 0.6 nm, allow deblending [NII]λ658.4 nm line from Hα (Lara-López et al. 2011), a feature unique in this type of surveys, which is essential for SFR and metallicity determinations. Each pointing is observed during 108 h, including overheads, with a requested seeing of $\leq$1 arcsecond.

For the maximum scientific explotation of OTELO, cross correlation with the ancillary data in the optical, Near-Infrared (NIR), X-Rays and Far-Infrared will be performed. Optical and NIR al-

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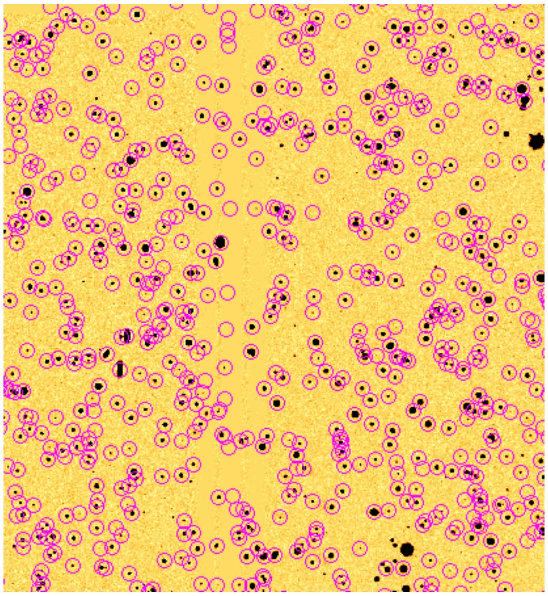

Fig. 1. Inverted median image of an OTELO pointing to the EGS. Encircled galaxies are 2300 sources identified in the catalogue of Gwyn (2011), up to magnitud $z\prime 23$. The field is 7.4×7.1 arcmin^2, with a total exposure time of 85800 s through a "synthetic" 924.4/8.4 nm filter.

low deriving photometric redshifts for identifying the emission line of the object detected, and obtaining morphologies. X-Rays allow identifying Active Galactic Nuclei (AGN), while 60–200 μm images of some OTELO fields obtained with the PACS instrument on-board Herschel Observatory using guaranteed time, will allow obtaining complete SEDs, deriving extinction corrected Star Formation Rates (SFR), and correlating extinctions and metallicities with FIR luminosities of the different sources detected.

The expected follow-ups include optical and NIR MOS of a fraction of the targets at $0.6 < z < 1.5$, i.e. those with Hα in the NIR domain and [OII]λ372.7 nm, [OIII]λ500.7 nm in the OTELO spectral window, for SFR and metallicity determinations.

2. OTELO IN THE CONTEXT OF OTHER EXTRAGALACTIC SURVEYS

In deep spectroscopic surveys, the sample selection has been done using broad band limited magnitude surveys. Then, they are biased to relatively bright continuum targets. OTELO survey is more focussed to faint continuum, spectroscopically unreachable targets with emission lines, thus providing a complementary view of the universe.

The most conspicuous emission line survey is that using Suprime-Cam in Subaru (see for example Ly et al. 2007). In comparison with this survey, OTELO will be 2 magnitudes deeper, and will detect equivalent widths 10 times narrower. Then, OTELO will detect most spirals at low redshift, instead of only the brightest ones. A fraction of ellipticals in emission will be detected for first time as well. As a summary, OTELO will be the first large-scale emission-line survey fully exploiting the sensitivity and the spectral resolution of tunable filters in a 10 m telescope.

3. SCIENTIFIC AIMS

A deep general purpose survey such as OTELO provides very valuable data for tackling a wide variety of projects. Science cases where OTELO will likely have the greatest impact include: SFR density evolution in the Universe, Lyα emitters, high redshift QSO, AGNs at any redshift, chemical evolution of the Universe up to $z = 1.5$, emission line ellipticals, and galactic emission stars.

The total number of emission line galaxies and its distribution within the different classes is a relevant science case on its own, given the present uncertainties in the evolution of the luminosity functions. Assuming no evolution and a cosmology with $\Omega_M = 0.3$, $\Omega_\Lambda = 0.7$, $H_0 = 65$ km s^{-1} Mpc^{-1}, the total number of emitters in OTELO survey is expected to be $\sim 1 \times 10^4$, with 77% spirals and ellipticals up to a redshift 1.5 and 0.84, respectively, 18% Seyfert galaxies at $z \leq 1.5$, 2% blue compact dwarfs up to $z = 0.85$, 2.5% Lyα emitters at z up to 6.7 (equivalent to 10% of the age of the Universe), and about 0.5% galactic emission stars. Since the low resolution spectra extracted from the data allow deblending the Hα from the [NII]$\lambda\lambda$654.8,658.4 nm lines, it will be possible estimating the metal contents of the targets and a zero-order discrimination between the various AGN types.

4. PRELIMINARY RESULTS

So far, only 33% of the first OTELO pointing has been observed, mostly in photometric conditions, with the last observations obtained recently. A detection image obtained by the median of 78 images, synthesizing a 924.4/8.4 nm filter, is shown in Figure 1. The histogram of the flux density of the 2300 sources with $z\prime$ from Gywn (2011) is shown in Figure 2, indicating that we are achieving a 3σ limiting flux of 5×10^{-19} erg cm^{-2} s^{-1}, as expected for a mean seeing of 0.9 ± 0.2 arcsec (best seeing 0.64 arcsec). Figure 3 shows some pseudo-spectra of typical

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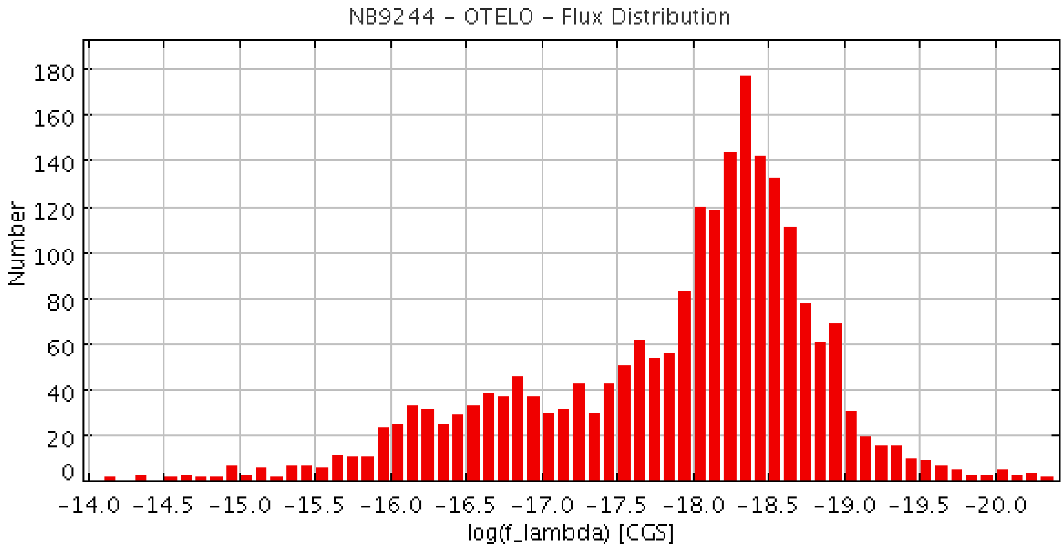

Fig. 2. Logarithm of the flux density distribution of the sources detected in the synthetic image of Figure 1.

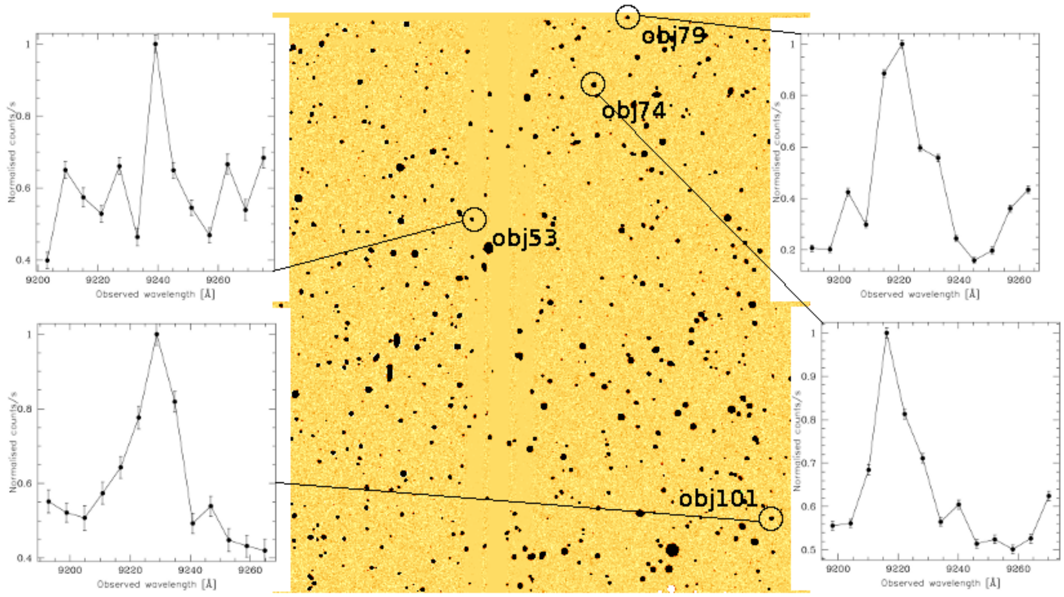

Fig. 3. Some spectra of typical Hα sources at $z \sim 0.40$ obtained adding only 2 exposures (out of 6) at each wavelength. The [NII]λ658.4 nm line can be observed.

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galaxies at $z \sim 0.40$ obtained adding only 2 out of the 6 exposures per wavelength available. The preliminary conclusions from the work so far done, indicates a lack of faint continuum targets (I(AB)$\leq$23.5) in absorption. Were this confirmed, the current SFR density estimations should be revised.

REFERENCES

Gwyn, S. D. J. 2011, arXiv:1101.1084
Lara-López, M. A., et al. 2011, PASP, 123, 252
Ly, C., et al. 2007, ApJ, 657, 738