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AGN INVESTIGATION IN THE OTELO SURVEY

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RESUMEN

El cartografiado OTELO de objetos con líneas de emisión usando los filtros sintonizables (TF) del instrumento OSIRIS en GTC proporcionará una muestra profunda y completa de Núcleos Galácticos Activos (NGA) y será capaz de discriminar éstos de las galaxias con formación estelar nuclear en base a cocientes de líneas de emisión. El cartografiado OTELO permitirá abordar numerosos interrogantes aún abiertos sobre la naturaleza de los NGAs y las galaxias que los albergan.

ABSTRACT

The OSIRIS Tunable Emission Line Object survey (OTELO) will provide a deep, complete sample of active galactic nuclei (AGN), and able to separate them accurately from nuclear star forming galaxies based on line strength ratios. The OTELO survey will be able to address several still open questions about the nature of AGN and their host galaxies.

Key Words: **GALAXIES: SURVEYS — GALAXIES: ACTIVE — GALAXIES: PHOTOMETRY**

1. AGN INVESTIGATION AND OTELO

In recent decades, research on active galactic nuclei (AGN) has become one of the most popular fields of astrophysics. Many fundamental questions regarding their origin, energy production mechanism, and relationship with their host galaxies still remain unanswered. For instance, we do not know if all galaxies pass through cycles of activity or whether such activity is related to their structural characteristics. Some of the many yet open issues include:

The density of active galaxies and the faint end of the AGN luminosity function Local Universe surveys (e.g., Huchra & Burg 1992; Ho et al. 1995, 1997) reveal than a large fraction (∼40%) of nearby bright galaxies show nuclear activity. Since Seyfert galaxies are much scarcer (2–10% depending on the survey), LINERs may make up about 70% of the AGN population. Nevertheless, the extension of these studies to fainter and farther AGN populations is plagued with difficulties; only nearby LINERs are expected to be detected in normal spectroscopic surveys since high S/N spectra are required and the faint nuclear spectrum is diluted by the host galaxy contribution. On the other hand, broad band color surveys are not sensitive to LINERs; hard X-rays constitute a powerful tool for detecting these kinds of low activity nuclei but their use is still limited by the availability of spacecraft data.

The striking dichotomy observed in the Hubble type distribution of nearby galaxies hosting AGN and nuclear star forming regions While AGN are quite common in early-type galaxies but very scarce in $T = 5$ (Sc) or later Hubble types, the opposite trend is observed in nuclear star forming galaxies, since they are very common in late-type objects but almost suppressed by $T = 2$ (Sb) and earlier.

In addition to this dichotomy, there are controversial clues concerning the connection between bars and other non-axisymmetric gravitational disturbances and nuclear activity, since they can provide an efficient transport mechanism for AGN fueling material (see, for instance, Arsenault 1989; Mulchaey et al. 1997; Ho et al. 1997).

The OTELO survey will provide an effective tool to address these and other important questions. It will be the deepest Hα narrow band imaging survey of emission line galaxies (ELGs) using OSIRIS tunable filters (TFs) at the GTC. Its ability to separate Hα and [N II] will allow to discriminate AGN from nuclear star forming galaxies. It will be able to de-

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TABLE 1

OTELO REDSHIFT WINDOWS

Window	Central z	Limits (Å)	Look-back time (Gyr)	Univ. age fraction
W1	0.09	7075–7250	1.4	12%
W2	0.24	8072–8247	3.6	28%
W3	0.40	9060–9300	5.1	40%

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tect Hα luminosities as weak as 5×10^{39} erg s^{-1} over a region of 6 kpc Ø at 5σ level in well-defined Universe volumes, since redshift bin widths at different z will be equivalent in cosmological time and the projected line of sight areas covered will be such that volumes at different z are equivalent. Table 1 shows the three nominal redshift windows defined for OTELO that will fill the current gap between $z = 0.1$ and 0.4. Its imaging capabilities will provide information about morphology and basic structural parameters. In addition, OTELO will be complemented by a broad band ($UBVRI$ or $ugriz$ plus K) survey allowing morphological identification and line identification through photometric redshift determination.

2. AGN IDENTIFICATION TECHNIQUES

The use of TF at OSIRIS will allow the separation between the Hα and [N II] lines; therefore, a standard emission line ratio diagnostic method can be used to separate AGN from nuclear starbursts. Ho et al. 1997 propose the following criterion: [N II] 6583 Å/H$\alpha > 0.6$ for AGN (either Seyfert or LINER nuclei) and [N II] 6583 Å/H$\alpha < 0.6$ for nuclear star forming regions. The selection technique is sensitive to LINERs and will probably detect a much larger fraction of Seyfert 2 galaxies than previous surveys in the blue since these objects are typically more heavily reddened than Seyfert 1 galaxies.

The ability of TFs to separate Hα and [N II] is accomplished by: a) TF scanning through a spectral range covering both lines; b) the scanning steps being a fraction of the filter FWHM (flux accuracy about 1% can be reached), and c) line profile recovery using Lucy or factorized deconvolution of the scan spectrum and the TF Airy profile. It is also possible to recover the flux of Hα and [N II] lines without deconvolving the scan spectrum by solving the appropriate system of equations involving the continuum-subtracted image fluxes, the TF transmissions, and the line fluxes and wavelengths.

Beyond the nominal redshift windows, OTELO can obtain useful results from "contaminant" sources. It will be possible to identify AGN based on different emission lines falling in the survey wavelength windows (Table 1) whenever suitable diagnostic methods are found. For instance, at $z = 0.9$ the [O II] 3727 Å and Hβ lines fall inside the W2 and W3 windows, respectively. In the diagnostic diagrams proposed by Rola et al. (1997) and defined by EW([O II] 3727 Å)/EW(Hβ) vs. log(EW([O II] 3727 Å)) and EW([O II] 3727 Å)/EW(Hβ) vs. log(EW(Hβ)), the loci of Seyfert, LINERs and nuclear star-forming galaxies are well-separated; according to these authors, this method is better than 90% efficient at separating AGN from nuclear star forming galaxies.

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