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LOW LUMINOSITY AGN CANDIDATES IN SDSS

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RESUMEN

En una muestra de 476931 galaxias con líneas de emisión agostas del Sloan Digital Sky Survey Data Release 5, identificamos y estudiamos galaxias de las cuales algunas importantes líneas de emisión usadas para determinar la naturaleza de su actividad ([OIII]λ5007Å, Hβ, o ambas) no están presentes. Este fenómeno afecta al 22% de las galaxias con líneas de emisión y no esta relacionado con una baja razón de señal a ruido. En el diagrama comparando el ancho equivalente EW([NII]λ6584) con la razón de línea [NII]λ6584/Hα, la mayoría de estas galaxias se clasifica como AGN. El FWHM de la línea Hα es del orden de 400 km s^{-1} y la luminosidad mediana es 5.6×10^{39} erg s^{-1}, lo cual justifica la clasificación de estas galaxias como AGN de baja luminosidad. Un estudio en sus historias de formación estelar usando STARLIGHT revela que no existe formación estelar en el último Giga año. Las galaxias anfitrionas de las LLAGNs son de tipo morfológico temprano con bulbos más masivos que los de AGN luminosas.

ABSTRACT

In a sample of 476931 NELGs obtained from the SDSS DR5 data we find that in 22% of the galaxies the emission line [OIII]λ5007, Hβ, or both, are missing. The nature of the activity in these galaxies was determined using a diagnostic diagram comparing the equivalent width of [NII]λ6584 with the ratio [NII]λ6584/Hα. The majority of these galaxies are AGN. The Hα emission lines have a mean FWHM of 400 km s^{-1} and mean luminosity of 5.6×10^{39} erg s^{-1}, which justify their classification as LLAGN. A study of their star formation histories using STARLIGHT reveals no trace of star formation over the last Gyr period. The hosts of the LLAGNs are early-type, $T \leq 2$, with bulges more massive than those of the luminous AGNs.

Key Words: galaxies: active

1. INTRODUCTION

Many galaxies show narrow emission lines in their spectra. We call them Narrow Emission Line Galaxies (NELGs). Following the seminal studies of Baldwin, Phillips, & Terlevich (1981) and Veilleux & Osterbrock (1987) various spectroscopic diagnostic diagrams were devised to determine the nature of their ionization sources. The majority of NELGs traces a sequence in ionization consistent with OB stars, which categorizes them as Star Forming Galaxies (SFGs). A smaller fraction shows an excess of ionization that cannot be explained by star forming activity. It is usually assumed that their source of ionization is non thermal. These galaxies are generally classified as Active Galactic Nuclei (AGNs). Galaxies falling in between SFGs and AGNs are then classified as Transition Type Objects (TOs).

In a sample of 476931 NELGs from the Sloan Digital Sky Survey Data Release 5 (Adelman-McCarthy et al. 2007) we find three different cases of NELGs where the most important emission lines used in standard diagnostics diagrams are missing. We count 68491 galaxies without Hβ, 27985 without [OIII] and 10926 without both lines. This represents 22% of the whole sample. Discarding NELGs with S/N $<$ 3 (S/N $>$ 10 in the continuum) leaves 224846 galaxies (47% of the original sample). We now count 34307 galaxies without Hβ, 12455 without [OIII], and 2840 without both lines, again amounting to 22% of the sample. This shows that the absence of emission lines is not a phenomenon related to low S/N.

Using the spectral synthesis code STARLIGHT (Cid Fernandes et al. 2005) the fluxes and EW in Hα and [NII]λ6584 were measured and compared to determine the activity type of the NELGs with emission lines missing (Coziol et al. 1998). We summarize our results in Figure 1. The majority of NELGs with emission lines missing fall on the AGN side of the diagram. This is particularly true for the galaxies without Hβ. The median Hα luminosity ranges between 1.7×10^{40} erg s^{-1} for the galaxies without [OIII], and 5.6×10^{39} erg s^{-1} for the galaxies without Hβ. The low luminosity justifies the classification of these galaxies as Low Luminosity AGNs (LLAGNs).

The NELGs with emission lines missing have broader line profiles than the SFGs. After correc-

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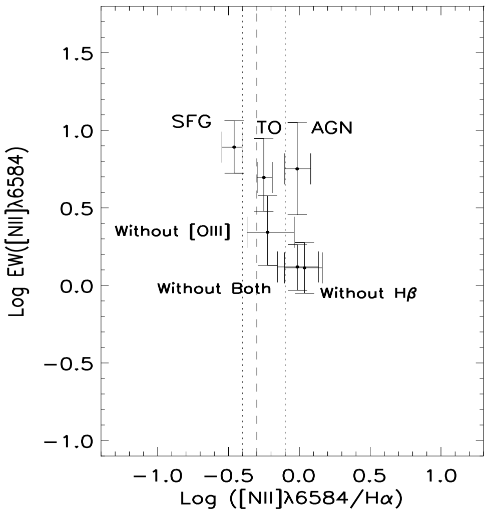

Fig. 1. NII diagnostic diagram; shown are medians and quartiles of NELGs with emission lines missing, compared with NELGs classified using standard diagnostic diagrams.

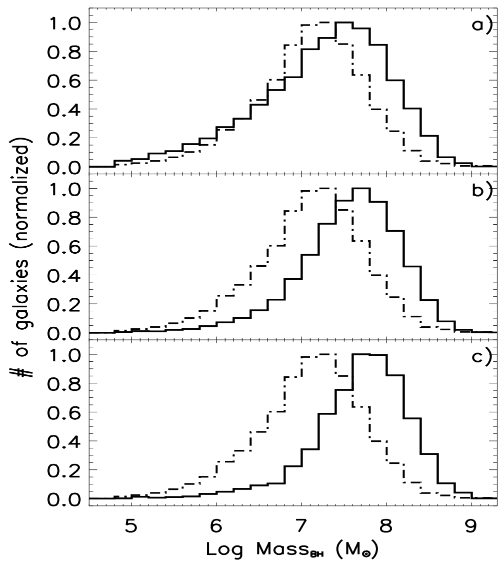

Fig. 2. Distributions of the bulge masses: (a) galaxies without [OIII]; (b) galaxies without Hβ; (c) galaxies without both lines. The point dashed line corresponds to the luminous AGNs.

tion for the resolution (Greene & Ho 2006), the FWHM of Hα fall between 25/75 percentiles 290 and 499 km s^{-1}. This is compared with 337 to 478 km s^{-1} in luminous AGNs and 253 to 292 km s^{-1} in SFGs. The gas producing the emission is moving at relatively higher speed in AGNs than in SFGs.

The morphology of the galaxies were determined based on photometric colors and inverse concentration index (Shimasaku et al. 2001). While the galaxies without [OIII] are late-type spirals, $T \geq 3$, the galaxies without Hβ and with both lines missing are dominantly early-type galaxies, $T \leq 2$. In general, the fraction of early type galaxies increases rapidly as the EW decreases. Consistent with the morphology classification, the star formation histories as determined by STARLIGHT indicate that the NELGs without Hβ and those with both lines missing show no evidence of star formation activity since $t = 10^9$ yr.

We compare the mass of the bulges as found in the three different samples of NELGs with emission lines missing in Figure 2. The bulges in the galaxies without Hβ and with both lines missing are generally more massive than in the luminous AGNs.

In their study of the activity of compact groups of galaxies Coziol et al. (1998) and Martínez et al. (2008, 2010) have found many examples of NELGs with emission lines missing, consistent with LLAGNs. Previous observations by Phillips et al. (1986) have also shown this phenomenon to be common in clusters of galaxies, affecting between 55% to 60% of all early-type galaxies. Although we do not have a definite evidence yet, our preliminary analysis suggests that more than 50% (87% for the galaxies without both lines) are in dense galactic environments. Therefore, the LLAGNs phenomenon may be related to a particular evolutionary phase of galaxies that formed in dense galactic environments.

There is presently no consensus among researchers on what is the physical nature of AGNs with low luminosity. However, according to the standard interpretation, an AGN is produced by the accretion of matter onto a massive black hole. Therefore, one possibility to explain the LLAGNs would be that the strong astration rates necessary to produce the massive bulges of galaxies in dense galactic environments have depleted the galaxies of most of their gas, affecting the accretion rates of their black holes.

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