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TYPE 2 AGN IN THE LOCAL UNIVERSE: TWO NEW INVARIANCES?

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RESUMEN

A partir de una muestra de AGN tipo 2 se estudia el posible efecto de la densidad medioambiental a gran escala (LSED, parametrizada por la densidad superficial) sobre la masa del agujero negro central (MBH) y la tasa de formación estelar (SFR) en esta clase de galaxias. Tras este estudio, no se encontraron evidencias de una dependencia entre estas variables y la densidad medioambiental. La presunta invariancia LSED-MBH sugiere que el mecanismo de formación de los agujeros negros en AGN a partir de la fusión de otros de masa inferior no es el que predomina. Por otro lado, la invariancia LSED-SFR es consistente con los resultados arrojados por estudios previos. Finalmente, se reporta una fuerte correlación entre la MBH y los índices de concentración en el óptico.

ABSTRACT

Starting from a sample of type-2 AGN, the effect of the large-scale environmental density (LSED, parametrized by the surface density) on the mass of central black holes (MBH) and SFR in AGN is studied. We find there is not apparent dependence between the environment and these variables. The invariance LSED-MBH suggests that there are not traces in the Local Universe of the possible assembling (build-up) of central black holes via galaxy merging, or that the mass growth of the black holes obeys to other different mechanisms not related with the environment that surrounds those AGN host galaxies. On the other hand, the invariance LSED-SFR is consistent with previous studies. A strong correlation between black hole mass in AGN and the SDSS concentration indexes is finally reported.

Key Words: galaxies: active — galaxies: statistics

1. INTRODUCTION

In the last years there have been important developments in the study of the Active Galactic Nuclei (AGN), in particular, the recent discovery of a correlation between the mass of the central black hole (MBH) and bulge velocity dispersion of the host galaxy (Gebhardt et al. 2000; Ferrarese & Merritt 2000) has generated a renovated interest in the determination of the MBH of different types of AGN. The environment that surrounds active galaxies has also been studied (Stauffer 1982; Dahari 1985; Rafanelli et al. 1995; de Robertis et al. 1998; Miller et al. 2003), however, there are not clear references in the literature about the role that the large-scale environment plays on some of the characteristic properties of AGN. In this paper we report our first attempt to study the effect of the LSED (parametrized by the surface density) on the MBH and the SFR in a sample of type-2 AGN extracted from the MPA/JHU collaboration catalogue (hereafter, Garching-DR4) available in `http:/www.mpa-garching.mpg.de/SDSS/DR4` (Brinchmann et al. 2004). As a parallel result, we also study the possibility to use concentration indexes for a delimitation of the MBH in this type of AGN.

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2. THE SAMPLE

We defined a volume-limited sample similar as it was made in Gómez et al. (2003) and Miller et al. (2003), that is, we restricted the analysis to galaxies brighter than $M(r^*) = -20.0$; this translates to a redshift range of $0.05 < z < 0.095$. Using this constraints, we extracted 9515 narrow-line AGN from the Garching-DR4 AGN catalogue, with signal-to-noise ratio $S/N > 3$, distributed in a ~ 2340 sq. degrees sky area.

3. LSED VS. MBH/SFR INVARIANCES

There are different methods to MBH calculation. In the case of type-2 AGN, to estimate the MBH we have used the well-known correlation between MBH and bulge velocity dispersion of the host galaxy σ^* given by Tremaine et al. (2002). The surface density was determined from the projected distance to the Nth companion (Miller et al. 2003; Gómez et al. 2003) and was evaluated taking into account the 3rd,

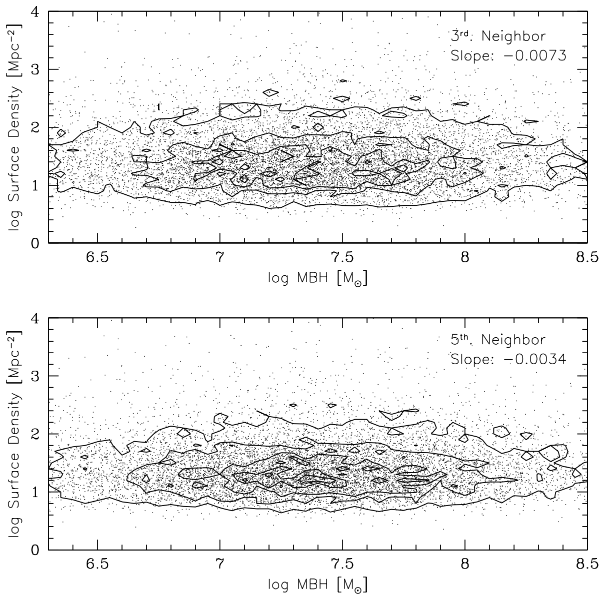

Fig. 1. Surface density evaluated at third and fifth nearest neighbour against black hole mass in AGN. The isocontours show the general trend. The slope of a linear fit of data is in the upper-right corner.

5^{th} and 7^{th} nearest neighbour, in order to consider different situations of the projected radius around the AGN. Border corrections to the surface density of galaxies were applied. The results for the 3^{rd} and 5^{th} neighbour is given in the Figure 1. At 1σ the slope of the data trend is practically zero in all cases. This demonstrates the lack of dependence between the surface density and the MBH.

As happen with the LSED-MBH relation, we do not find a dependence of the local type-2 AGN density with SFR, derived using the strong existing correlation between the Dn(4000) index and the specific star formation rate (SFR/M*) (Brinchmann et al. 2004).

4. DISCUSSION

We find there is not apparent dependence between the environment and the growth in MBH. This suggests that if the galaxy merging has been a relevant phenomenon in the galaxy formation and evolution, just as it is accepted today, it does not seem to be the mechanism for the growth in the MBH of the type-2 AGN. In other words, this result strengths (i) the hypothesis about the existence of primordial black holes in AGN and (ii) the mass accretion from the host galaxy as the most generalized mechanism to explain the growth of them. Nevertheless, another type of events could explain these results. Haehnelt et al. (2006) find a possible evidence for the ejection of a supermassive black hole from an ongoing merging of galaxies. A high frequency of such events during the coalescence of galaxies that could also shed light on the results reported here.

We have not found any relation between large-scale environmental density and star formation rate in AGN of the sample. It point out to a different environmental behavior of AGN hosts with respect to starburst galaxies, as confirm Gómez et al. (2003) and Bongiovanni et al. (2005), and, consequently, the star formation triggering mechanisms probably obey to small-scale phenomena.

A correlation was found between black hole mass in AGN and the concentration indexes from Garching-DR4. This fact not only imply that the optical concentration indexes could trace the MBH at least in this AGN type (with not much observational effort), but that expand a previously observed result in nearby, resolved galaxies, to a large homogeneous sample at low redshift. The physical interpretation of the observed correlation in not seems to be so straightforward: it is possible that the galaxies with higher concentration indexes and bulge masses (in other words, with higher potential wells), would generate better conditions for an efficient mass provision for black hole accretion, in the sense of our first conclusion. Consequently, the velocity dispersion in the bulge will be increase proportionally.

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