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INDUCED NUCLEAR ACTIVITY IN GALAXY PAIRS

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RESUMEN

Analizamos espectros del núcleo de 893 galaxias entre pares de galaxias y galaxias aisladas de la muestra SLOAN (DR7). Estos pares pueden ser divididos en tres grupos: S+S, E+E y E+S de acuerdo con el catálago de pares aislados de galaxias de Karachentsev (KPG). También analizamos dos muestras de galaxias aisladas: el catálogo de galaxias aisladas de Karachentseva (CIG) y la muestra de galaxias aisladas en el hemisferio norte de Varela. Estudiamos la incidencia de la actividad nuclear en cada grupo. Nuestros resultados muestran que la incidencia de actividad nuclear es significativamente mayor en galaxias pares que en las aisladas. Más aún, mostramos que esta incidencia es mayor para galaxias con morfología de tipo temprano. La presencia del bulbo parece ser crucial para explicar cómo se alimenta el hoyo negro supermasivo en AGN. También confirmamos que los AGN de tipo 1 están casi ausentes en toda la muestra. Este resultado no es posible explicarlo tomando sólo en cuenta un modelo unificado.

ABSTRACT

We analized the nuclear spectra of 893 galaxies in isolated pairs from the Sloan Digital Sky Survey (DR7). These pairs can be divided into three groups: S+S, E+E, E+S according to the catalogue of isolated galaxy pairs (KPG) by Karachentsev. We also analyzed two samples of isolated galaxies: the catalogue of Isolated Galaxies by Karachentseva (CIG) and Varela's sample of northern isolated galaxies. We studied the incidence of Nuclear Activity in every group. Our results show that the incidence of AGN activity is significantly higher in most galaxies in pairs as compared to isolated. Most importantly, we show that this is stronger for earlier morphological types. The presence of a bulb appears to be crucial in explaining the feeding of super massive black holes in AGN. We also confirm that Seyfert type 1 nuclei are almost absent. This result cannot be explained with the unified model for Seyferts only.

Key Words: H II regions — ISM: jets and outflows — stars: mass loss — stars: pre-main sequence

1. INTRODUCTION

The first studies of the extragalactic influence on AGN, were devoted to investigate the difference in the environment between active and non-active galaxies, without distinguishing activity type. More recently, the importance of making a difference between close and large scale environment, has become clear. The first studies were affected by the lack of clear definitions, statistical biases and also biases introduced by sample selection effects. All these methodological problems have yielded contradictory results that can be found in the literature for over more than 20 years. One of the first discussions of these effects is given in Dultzin-Hacyan et al. (1999). As more refined studies have been performed, it has become clear that Seyfert 2 galaxies are in interaction with the same frequency than Star-Forming Galaxies (SFG) (e.g., Storchi-Bergmann et al. 2001; Krongold et al. 2001), while Seyfert 1 galaxies are in interaction less frequently.

In the present paper we adopt a complementary approach. We study the incidence of nuclear activity in a well defined sample of interacting galaxies in pairs and compare with a two samples of true isolated galaxies.

2. SAMPLE

Our study consists on three galaxy samples. The catalog of Isolated Pairs of Galaxies (CPG; Karachentsev 1972) from which we obtained three groups of pairs E+E, E+S and S+S including S0 galaxies as elliptical. The control samples are: The Catalog of Isolated Galaxies (CIG; Karachentseva 1973) and a Northern Isolated Galaxy catalogue compiled by Varela et al. (2004). We obtain all available spectra from the Sloan Digital Sky Survey Data Release 7 (SDSS-DR7) for all the samples.

A total of 893 nuclear spectra of galaxies have been extracted from (both paired and isolated galaxies). We focus in measuring the intensity of the strongest emission lines: Hα, [OIII] λ5007, Hβ, [NII] λ6584, with a signal to noise ration (S/N) > 3. Host

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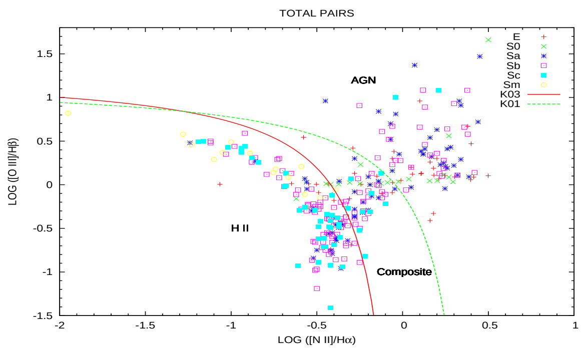

Fig. 1. BPT (a) diagram for total of galaxies in pairs.

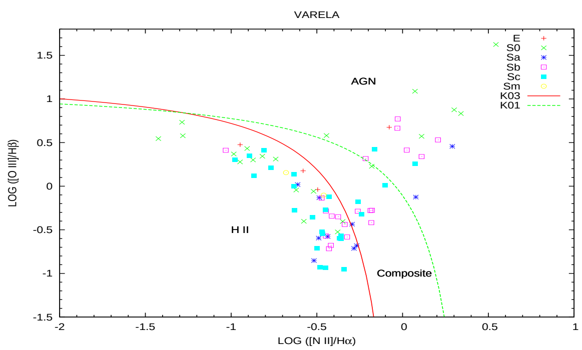

Fig. 2. BPT (a) diagram for Varela's sample.

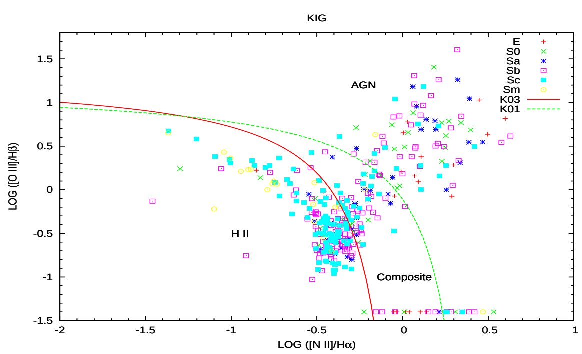

Fig. 3. BPT (a) diagram Karachentseva's sample.

galaxy continuum have been removed with a software which combines stellar population synthesis models with PCA (Principal Component Analysis) optimized by J. Perea for this work.

3. ANALISIS

We based our optical classification in the BPT (a) diagnostic diagram (Baldwin et al. 1981). We built the BPT diagram with two optical line ratios [O III]/Hβ, [N II]/Hα. Adopting two lines for the separation of galaxies into AGN, composite galaxies (AGN plus starburst features) and HII galaxies (comprising both starburst (SB) and star forming galaxies). See Kewley et al. (2001, hereafter K01) for the line that separates AGN from SB, and see Kauffmann et al. (2003, hereafter K03) for the empirical line dividing pure star forming galaxies from AGN-starburst composite Objects.

Figures 1, 2 and 3 shows the [O III]/Hβ vs [N II]/Hα BPT (a) diagram; the green dotted line represents K01 and the red continues one K03. Galaxies that lie above of K01 line are considered to have AGN nuclei. If galaxies are between the green and red lines are classified as COMPOSITE. Composite galaxies can be a mixture of nuclear star formation and a Seyfert nucleus or LINER's emission. We also show the morphological classification of the galaxies in the figures. The presence of activity with broad lines (AGN type 1) is almost absent in this work ($< 3\%$).

4. IMPORTANT RESULTS AND CONCLUSIONS

The higher incidence of nuclear activity in close (< 100 kpc) paired galaxies can be interpreted as the result of gravitational interaction in pairs. The enhanced activity is clearly present in pairs E+E, E+S. In contrast, galaxies in S+S pairs show a similar proportion of activity as compared to spiral isolated galaxies. This confirms that AGN nuclei are found in earlier morphology host galaxies (Sa-Sb). In E+E pairs the nuclear activity is 60%, very similar to elliptical galaxies in Karachentseva's sample. So, what plays a more relevant role in the tidal triggering of activity in a close pair of galaxies? The separation between them or the size of their bulbs? an important question that soon can have response.

The almost total absence of AGN type 1 activity cannot be explained with the Unified Model only, at least in its simplest version. An evolutionary scenario first suggested in (Krongold et al. 2002, 2003) can explain this results and does not exclude an obscuration plus inclination effect.

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