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Interaction between galaxies, the impact on their physical properties

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Abstract

Here we present a study of the physical properties and nuclear activity of the new detected interacting galaxy selected from the Arp & Madore Catalogue [1]. The data were obtained using the GMOS-S spectrograph at the Gemini-South telescope with spectral coverage from 350nm to beyond 800nm (rest wavelength) and with spectral resolution enough to separate the [NII]+Hα blend. The slit was aligned to include both (or two of the) galaxies, and to improve sky subtraction.
In order to determine the physical condition of the ionized gas and the nuclear activity of each galaxy, a central 2kpc spectrum, free from stellar population contribution, was obtained.
The redshift was measured using IRAF tasks rvidlines and xcor, for emission and absorption spectra, respectively , adopting H= 75 km/sec Mpc . In order to determine if the galaxies form a physical system, we constraints the difference between their radial velocities in $\Delta V < 500$ km/sec.
We found that 81 of the 107 observed galaxies are real physical systems. The same procedure was used to built a pure emission line spectrum of a isolated control sample galaxies. These galaxies were selected from SDSS survey, which the r' magnitude, redshifts and morphology are similar to the pair members. For all galaxies, of both samples (physical pairs and isolated) the emission lines were identified and their fluxes were measured. The lines fluxes were corrected by dust extinction according Osterbrock (1989)[2]. Special care was taken with errors propagations. Once the intensity of the emission line spectrum is sensible to radiation field, electron density and temperature, one can use diagnostic diagrams (BPT, Baldwin, Phillips and Terlevich, 1981[3]) to classify the sources according to their nuclear activity (Seyferts, LINERs, Starburst, and composite spectrum - wich may indicate the presence a weak AGN component). We built several diagnostic diagrams with the emission line ratios: [OIII] 5007 Å / Hβ 4861 Å vs [NII] 6584 Å / Hα 6563 Å , [OIII] 5007 Å / Hβ 4861 Å vs [SII] 6717,6730 Å / Hα 6563 Å , [OIII] 5007 Å / Hβ 4861 Å vs [OI] 6300 Å / Hα 6563 Å and [OIII] 5007 Å / [OII] 3727 Å vs [OI] 6300 Å / Hα 6563 Å. The theorical and empirical divisions curves of Kewley et. al. 2001[4] and Kauffman et. al. 2003[5] and 2006[6] were used. From this diagrams it was possible to conclude that the fraction of galaxies of different activity types is not the same for both samples. We found 60% of the physical pairs have a composite spectrum and similar fraction (20%) are SB or AGN. While for isolated galaxies 30% are composite, 50% are SB, and 20% are AGN.

Diagnostic diagrams (DG)

Pairs

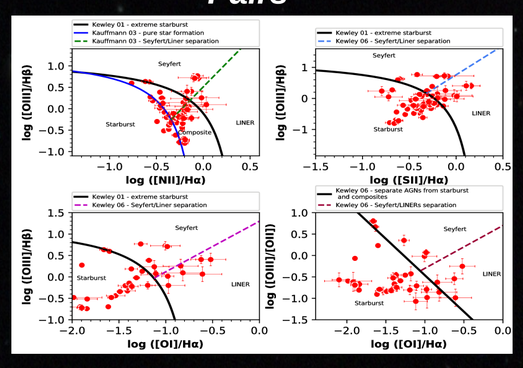

Figure 1. The emission lines ratios log([OIII]/Hβ) vs log([NII]/Hα) of the interacting galaxies shows that most of them have starburst or composite spectral type. The remain objects are Seyfert or LINER. The others DGs with [SII] or [OI] lines increase the fraction of AGN type, confirming the hypothesis that composite spectrum have a weak AGN component.

Control sample

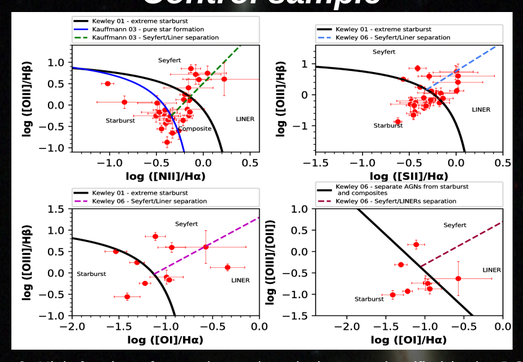

Figure 2. High fraction of control sample galaxies are classified in the DGs as starburst spectral type, and few have composite type. For the galaxies wich was possible to measure [SII] and [OI] the fraction of both of Starburst and AGN are similar, indicating that the composite galaxies may have a AGN component.

The nature of nuclear activity

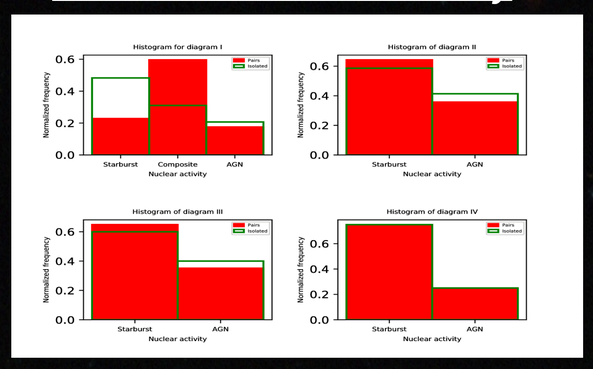

Figure 3. The histograms present quantitative results of the DGs. The upper left panel shows that the 60% of interacting galaxies (red bars) have a composite type spectrum, and similar fractions (~20%) are starburst or AGN. In the others histograms the fraction of starburst and AGN increase in about 40% and 20% respectively.
The left upper panel show that the fraction 50% of the control sample (green lines) are starburst and 30% and 20% are composite or AGN respectively. The same behavior of increasing both types of activity (starburst and AGN) happen in the others histograms.

Emission lines spectra of interacting pairs

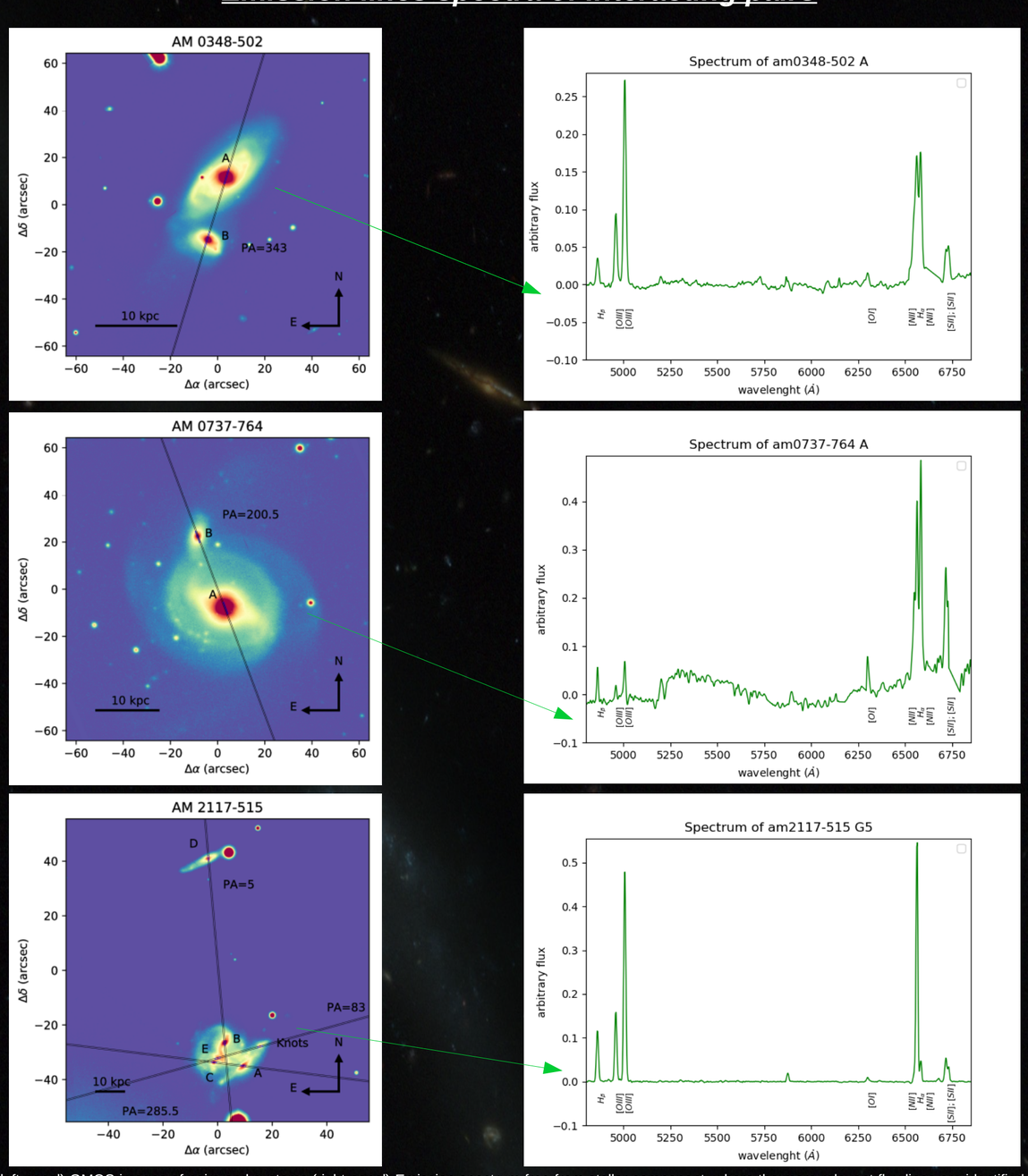

Figure 4. (left panel) GMOS images of pairs and systems.(right panel) Emission spectrum free from stellar component, where the more relevant flux lines are identified. Using lines intensity ratios it is possible to set the nature of the energy source of ionized nuclear gas. The AM0348-502 A spectrum was classified as Seyfert, AM0737-764 as LINER and AM2117-515 G5 were classified as Starburst.

Conclusions

We measure the fluxes of the lines, in a spectrum extracted from the nuclear region with a size of 2 kpc for 81 galaxies of physical systems. These galaxies belong to new detected systems from Arp & Madore Catalogue [1]. To determine the nuclear activity type, we used a spectra free of contamination of stellar population. The more commom lines observed are the recombination lines of hidrogen Hβ and Hα, and the forbidden lines ([OII]3727Å, [OIII]4959;5007Å, [OI]6300Å,[NII]6848;6583Å and [SII]6717;6731Å). The same procedures was taken to the control sample of isolated galaxies, to compare similar galaxies in differents enviroments, to determine the effects of interaction in the evolution of galaxies.

The lines fluxes was corrected by extinction using the standard reddening law of the Galaxy (Seaton, M. J., 1979 [7]), assuming Hα/Hβ=2.86 (compatible with HII regions) as the intrinsical ratio between this lines to calibrate the method discribed in (Osterbrock 1989[2]).

We built diagnostic diagrams with line ratios using the theorical curves of (Kewley 2001[4]) and empirical curves present in (Kauffman 2003[5]) and (Kewley et al 2006[6]) in order to separate different activity types. The BPT diagram (upper left panel in Figure 1) shows the predominance of starburst and composite spectrum in the pairs sample. In others DGs, wich can't separe composite type, increasing the ocurrency of AGN and starburst types, confirming the hypothesis of AGN component in the composite type.

Through histograms (Figure 3) obtained of DGs data was possible quantify the fraction of every type of nuclear activity. For BPT diagram was possible distinguish pairs and isolated galaxies, because pairs have a most commom presence of composite galaxies (60%) and equal fraction of starburst and AGN (~20%), probably an interacting effect. While the control sample of isolated galaxies have a high presence of starburst (50%), 30% and 20% of composite and AGN, respectively. The others histograms no can separe composite spectrum, increasing both starbursts and AGNs. These results suggest that, interaction would be an efficient mechanism to triggering nuclear activity in galaxies.

References

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