

# Spectroscopic Observations of Peculiar Galaxies at $z < 0.1$

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**Abstract.** We present spectroscopic observations of 15 peculiar interacting galaxies (Category 2: Interacting Doubles) from the ‘Catalogue of Southern Peculiar Galaxies and Associations’. The nuclear spectra obtained with the 1.6-m telescope at the Pico dos Dias Observatory (OPD/LNA-MCTIC) reveal an important set of absorption and emission lines in the optical range 3700-7000 Å. Radial velocities, relative emission-lines intensity measurements and spectral classification are discussed. We use the stellar population synthesis code STARLIGHT and classical diagnostic-diagrams to determine the nuclear nature of this particular sample.

**Resumo.** Apresentamos observações espectroscópicas de 15 galáxias peculiares interativas da Categoria 2, ‘Duplas Interagentes’, do ‘Catálogo de Galáxias Peculiares e Associações do Hemisfério Sul’. Os espectros nucleares obtidos com o telescópio de 1,6-m do Observatório Pico dos Dias (OPD/LNA-MCTIC) revelam linhas de absorção e de emissão na faixa óptica 3700-7000 Å. Velocidades radiais, intensidades relativas dos fluxos das linhas de emissão e classificações espectrais são discutidas. Usamos o código de síntese de população estelar STARLIGHT e diagramas diagnósticos clássicos para determinar a natureza nuclear da amostra estudada.

**Keywords.** Galaxies: clusters: general – Galaxies: elliptical and lenticular, cD – Techniques: spectroscopic

## 1. Introduction

It is now widely recognized that galaxy-galaxy interactions play an important role in their evolutionary processes, with the presence in many cases of energetic activities in their inner regions. The connection between enhanced nuclear activities and gravitational interactions has been discussed in the literature by many authors (e.g. Heckman 1990; Sabater et al. 2013; D’Onofrio et al. 2016). Although the idea of interaction-induced nuclear activities is well established with theories and observations, many points related to the mechanisms of excitation and morphological properties still need to be discussed. To contribute to this subject we have started a spectroscopic survey of the nuclei of interacting galaxies from the ‘Catalogue of Southern Peculiar Galaxies and Associations’ (Arp & Madore 1987, hereafter AMC), with the Cassegrain spectrograph of the Observatório do Pico dos Dias (LNA/MCTIC).

## 2. Sample Selection

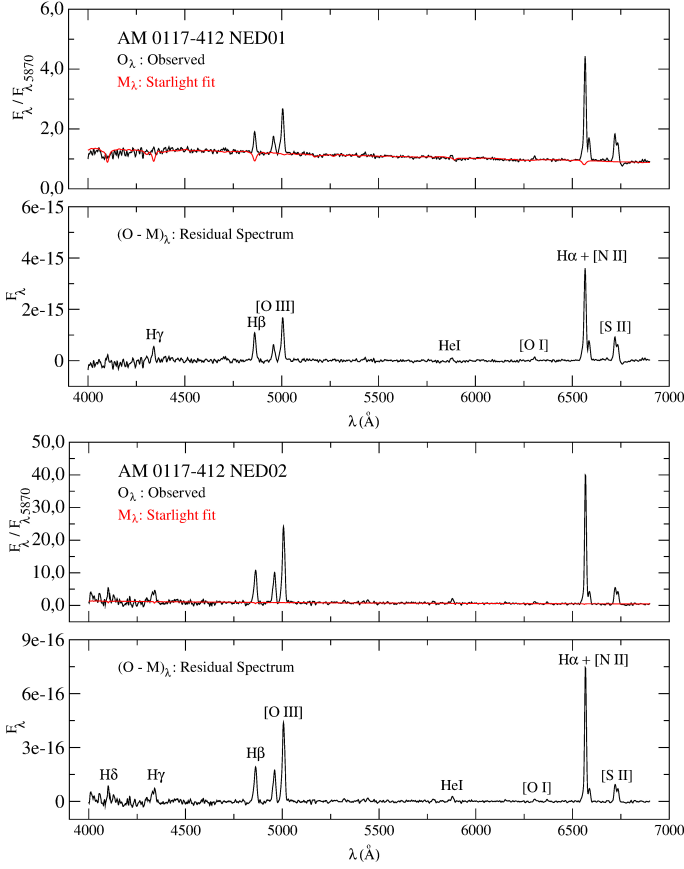
The aims of this work are to present optical spectra and to provide an analysis of the data for a small sample (15) of interacting galaxies in AMC. We have focused our attention to the Category 2: Interacting Doubles. Galaxies in this Category are more or less equal in size and show strong signs of interaction. The observed galaxies are listed in Table 1 (literature).

**Table 1:** Category 2: Interacting Doubles. Values taken from NED/NASA-IPAC: galaxy identification from the AMC, morphological type, heliocentric velocity and nuclear activity.

ID	Object AM	Type	cz (km s <sup>-1</sup> )	Activity
1	0053-321 NED01	S0 <sup>-</sup> ? Pec	9607±22	Liner?
2	0053-321 NED02	Sbab? Pec	9538±38	–
3	0117-412 NED01	–	5052±36	–
4	0117-412 NED02	–	5267±53	–
5	2055-492 NED01	(R)SB(r)a	6912±28	–
6	2055-492 NED02	(R)SAB0 <sup>+</sup>	6725±62	–
7	1926-393E	Pec	2755±30	–
8	1926-393SE	Pec	2772±25	–
9	1926-393W	Pec	2820±43	–
10	2339.661 NED01	(R’)_SB(s)bc	10168±10	Sy2
11	2339.661 NED02	(R’)SB(rs)b	10574±18	–
12	0207-233	Sbc	5332±9	H II
13	0408-561	(L)SB(rs)0 <sup>+</sup>	790±5	Liner
14	2034-274 NED01	SB(r)b:	606±9	–
15	2316-395	Interacting	26662±120	H II

## 3. The Starlight Code

STARLIGHT is a code used to fit an observed spectrum ( $O_\lambda$ ) with a model ( $M_\lambda$ ) in terms of a linear combination of simple stellar populations (SSPs). We use a base of  $N^* = 150$  elements of 25 different ages between 1Myr and 18 Gyr, and 6 metallicities.



**FIGURE 1:** Example of spectral synthesis. Top panels: observed spectrum ( $O_\lambda$ , black line, corrected by redshift and Galactic reddening) and synthesized spectrum ( $M_\lambda$ , red line, the ‘best fit’ population synthesis model) normalized to unit at 5870Å. Bottom panels: residual spectrum after starlight subtraction. Both  $O_\lambda$  and  $M_\lambda$  are given in units of  $\text{erg cm}^{-2} \text{s}^{-2} \text{Å}^{-1}$ .

ties:  $Z^* = 0.005, 0.02, 0.2, 0.4, 1.0$  and  $2.5 Z_\odot$ , summing up 150 SSPs (see Mateus et al. 2006; Cid et al. 2007; Asari et al. 2007 for more details). STARLIGHT has a suite of reddening-laws options and we have used some of them to model the extinction in a multi-dimensional chi-square fit: CCM: (Cardelli et al. 1989) and CAL: (Calzetti et al. 1994, 1995).

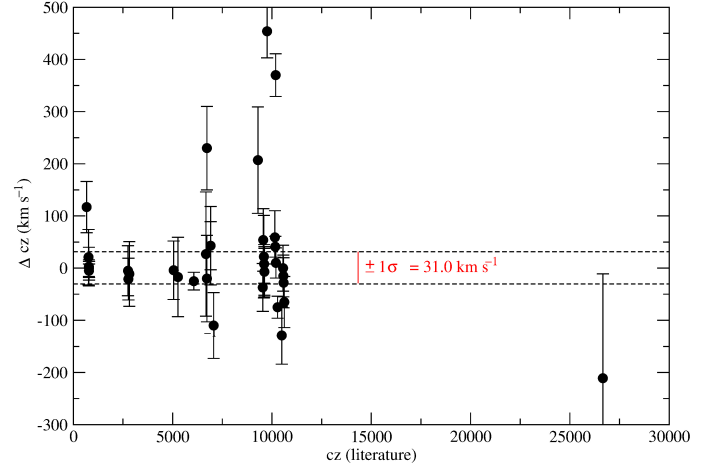
#### 4. Results and Conclusions

The long-term observational programme OP2012A-LP12 aims to study the properties of peculiar galaxies in the local universe ( $z < 0.1$ ). We provide the spectral classification for most of them: ID = 2, 3, 4, 5, 6, 9, 11 and 14. We confirm the previous classification for ID = 10, 12, 13 15 and we suggest ID = 1 as a Seyfert 2 galaxy. The radial heliocentric velocities are located within  $\pm 1\sigma$ , which confers the potential of the spectroscopic observations.

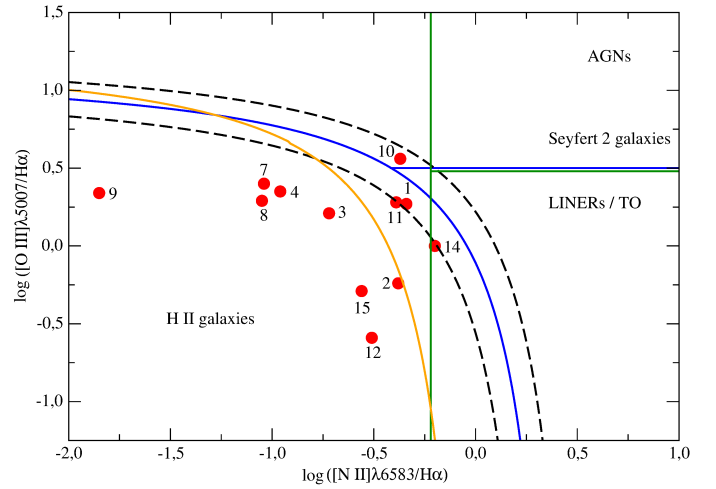
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**FIGURE 2:** Difference between the radial heliocentric velocities (this work minus literature). The  $\pm 1\sigma$  was estimated in 31 km/s.



**FIGURE 3:** Diagnostic diagram  $\log [O III]/H\beta \times \log [S II]/H\alpha$ . The full lines correspond to the empirical separations between narrow-line AGNs and H II galaxies and Seyfert 2 galaxies and LINERs, deduced by (Kewley et al. 2001) and (Filippenko & Terlevich 1992). The orange line represents the division between H II regions and AGNs obtained by (Kauffmann et al. 2003).

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