Balogh vs Dressler: Spectral classification

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1 SPECTRAL CLASSIFICATION

Follow the methods obtains from Balogh et al. (1999) with the data from Dressler et al. (1999), the aim of this essay is replicate the same figures 9 and 11 from the first paper mentioned with the data of the second, to understand how the classification of Balogh is better in fuction to separete between star forming and passive galaxies.

2 METHODS

One of the first thing that we do to understand the comparison between the two jobs, is to review the meta-data of the data to homogenize the tables. In the case of Dressler et al. (1999) we have: *the EW of the Hδ is negative when the line present* ***emission*** (see figure 1). In comparison, the description about this two line features in Balogh et al. (1999) is: ... *When the EW [O II] index is positive the line is in emission, while the EW Hδ index is positive when the line is in* ***absorption***.. This implies that the data for *Hδ* from the Dressler et al. (1999) catalogue is the same in both catalogues,and [O II] needs to be multiplied by −1 to homogenize the data. Doing that, we replicate the fig. 9 and fig. 11 from the paper of Balogh et al. (1999) (see figure 2).

Using a `python` libraries, we made the sames figures (see figure 3 and figure 4)

3 ANALYSIS

We made the sames graphics from Balogh et al. (1999) ussing the data provided by Dressler et al. (1999), but with the aim to do the same morphological classification, we depure the data, excluding the galaxies from the *field* and unified the morphological classification from Dressler et al. (1999), i.e. we use the column of *MType* in function to obtain *E/S0, Sab, Sbcd, Irr/SB*, see figure 6 and 7. And also, we made the plots separate by cluster.

In two cases, we can see a poorly stadistic. In order to confirm, we made the count of number of galaxies per cluster in the figure 8. It is important understand the context, this two papers was the first in the area of the spectral classification, but the data was be used carefully.

NOTES ON THE PARAMETERS IN TABLES 4A AND 4B

Column	Parameter	Units	Format	Comment
1.....	CLUSTER		A6	Cluster
2.....	ID		I4	ID in spectroscopic catalog for cluster
3.....	z		F7.4	Redshift
			A1	Redshift quality; colon indicates questionable identification
4.....	Q		I2	Quality of spectrum: 1 = High, 4 = Low
5.....	[O II]	Å	F7.1	Rest frame EW of [O II] 3727
			A1	Quality of [O II] 3727 EW measurement (colon indicates questionable)
6.....	Hδ	Å	F4.1	Rest frame EW of Hδ, −ve indicates emission
			A1	Quality of Hδ EW measurement (colon indicates questionable)
7.....	D4000		F5.2	Break strength index
8.....	CLASS		A11	Spectral classification in scheme described in § 3.3
9.....	δRA	arcsec	F7.1	RA offset from field center in Table 2
10	δDec	arcsec	F7.1	Dec offset from field center in Table 2
11	ID_{HST}		I5	ID in photometric catalog for cluster[a]
12	X	pixels	I5	X coordinate on WFPC2 frame[a]
13	Y	pixels	I5	Y coordinate on WFPC2 frame[a]
14	MORPH		A12	Galaxy morphology[a]
15	T		I2	T type[a]
16	D		I2	Visual disturbance index[a]
17	INT		A6	Interpretation of disturbance[a]
18	MAG	Mag	F5.2	Total magnitude in F702W/F814W from WFPC2 frame[a,b]
19	COL	Mag	F5.2	Aperture color from WFPC2 frame[a,c]
20	MAG_{DG}	Mag	F6.2	Magnitude from ground-based imaging published in DG92[d]
21	COL_{DG}	Mag	F6.2	Color from ground-based imaging published in DG92[d]
22	RUN		A6	Code giving details of observing run[e]
23	MASK		A10	Mask and object slit identifier
24	FEATURES		A23	Spectral features identified; see § 3.1
25	COMMENTS		A130	Description of features in spectrum

[a] See S97 for more details.
[b] Magnitudes are in F702W for Cl 0303+17, Cl 0939+47, 3C 295, Cl 1447+26 and Cl 1601+42, and in F814W for Cl 0016+16, Cl 0024+16, Cl 0054−27, A 370 Field 2, Cl 0412−65, Cl 0939+47 Field 2.
[c] WFPC2 $V_{555}-I_{814}$ color information is available for: Cl 0016+16, Cl 0054−27, A 370 Field 2, Cl 0412−65, Cl 0939+47, and $B_{450}-I_{814}$ colors for Cl 0024+16.
[d] Aperture r-band magnitude from DG92, colors are aperture $(g-r)$ measurements in all instances.
[e] [P/W/N]<MONTH><YEAR>, P = Palomar 5 m, W = WHT, N = NTT, or DG92.

Figure 1. Capture of the table 5 from Dressler et al. (1999)

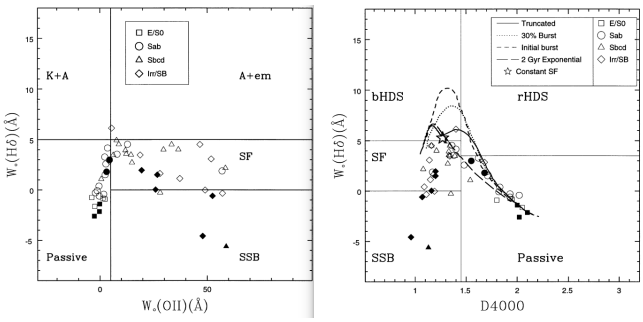

Figure 2. figures 9 and 11 from the paper of Balogh et al. (1999)

3.1 Hδ and the color

Hδ is an spectral line of absorption (Balmer's Series) related with the stars A and F. This line is strong in presence of recent star formation. So the EW Hδ is a good indicator of recent star formation, and in relation to the color of the galaxies, is physically expected that the red galaxies has a low EW Hδ and the blue galaxies show a high EW Hδ, but in the data there is not so evident in the figure 3. In the case of the figure 4, the relation of the color and Hδ is more noticeable, but probably the relation with the color is for

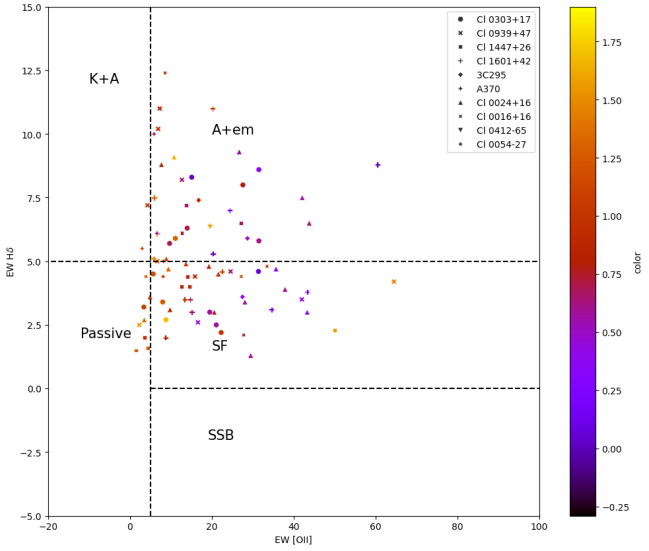

Figure 3. Figure made to replicate the first panel of the figure 2, this show the relation between the EW of $O[II]$ and EW of $H\delta$

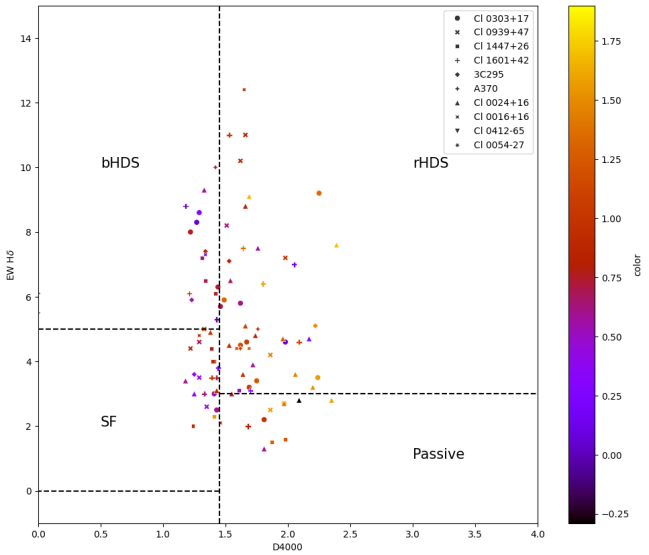

Figure 4. Figure made to replicate the second panel of the figure 2, this show the relation between the EW of $O[II]$ and EW of $H\delta$

the D4000 parameter, that literally is related with the stellar continous of the galaxies, and this is related with the star formation history, i.e. the recent star formation. With this, we expected that the red galaxies show a high D4000 and the blue galaxies a low D4000, related with the age of the stellar populations.

3.2 O [II] and the color

O[II] is an spectral line of emission with origin in the transition between energetic levels in the Oxygen atoms. In the context of the galaxies, this line be present when the young stellar populations (O, B stars) ionize the gas in the interstel-

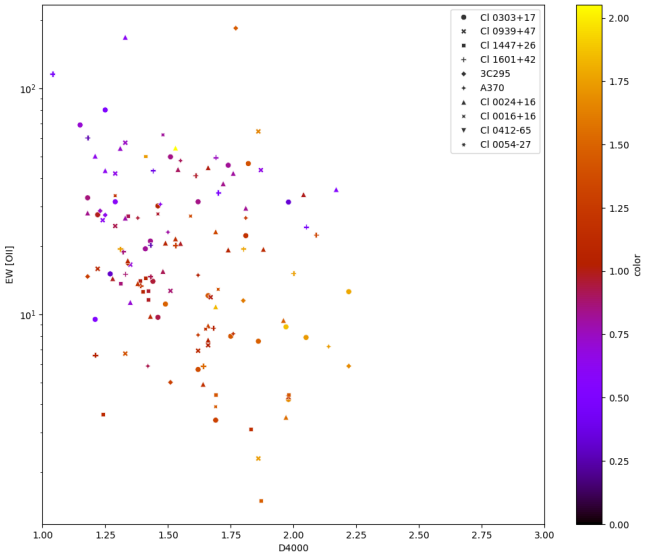

Figure 5. This figure show the relation between EW of $O[II]$ vs D4000

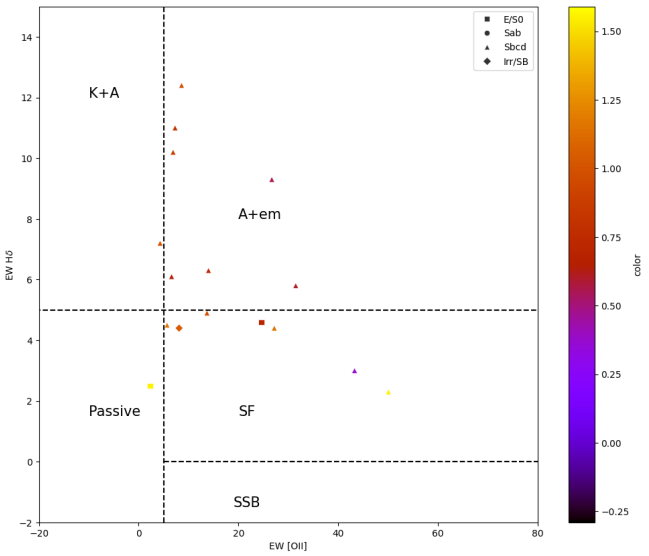

Figure 6. Figure to replicate the second panel of the figure 2, were replacing the morphology of the galaxies in function to have the sames of Balogh et al. (1999)

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lar medium by their hot atmospheres, this is quickly related with the age of the star in a galaxy and we expected also, a high relation between the EW O[II] and the color of the galaxies, pointing to the color of the stellar populations. In this case we expected that the red galaxies has low or null EW O[II] and the blue galaxies has a high value for EW O[II]. The figure 3, show a correlation between the colors and the EW O[II], if we have a high EW O[II], the galaxies are more blue.

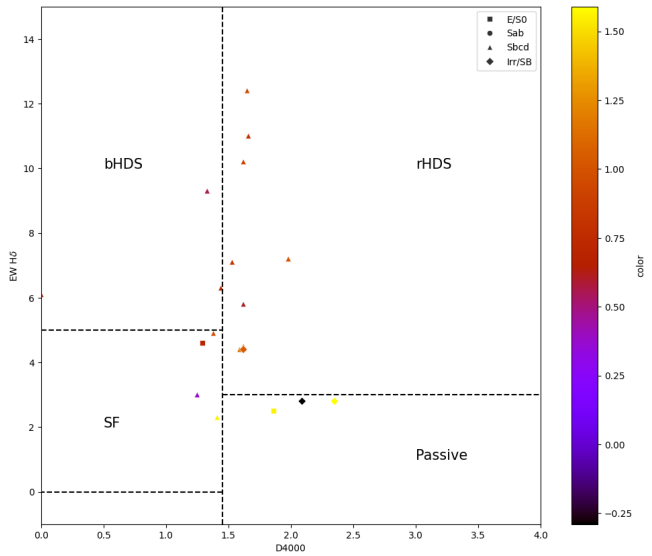

Figure 7. Figure made to replicate the first panel of the figure 2, were replacing the morphology of the galaxies in function to have the sames of Balogh et al. (1999)

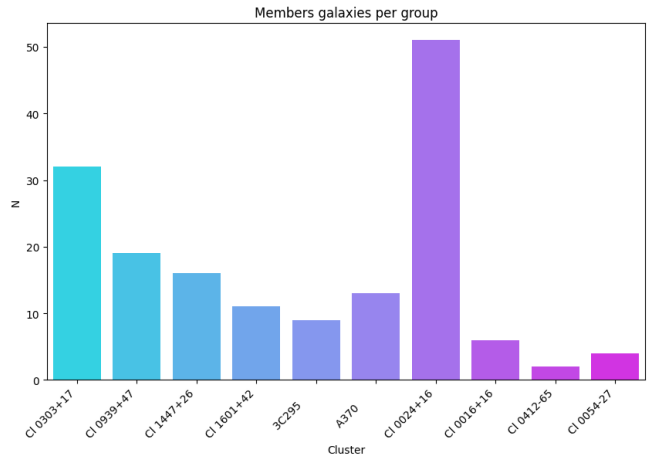

Figure 8. Histogram for the count of galaxies per cluster

3.3 The classification

To analyze the feature of the galaxies inside the "boxes" of classification, it is understood the physics concept behind, and the definitons are specified in Balogh et al. (1999). But we can see, that the red galaxies are in agree with the Passive and K+A galaxies. In the case of the trnasition galaxies, that can be a "green" color galaxies, are distributed for all the data. The blues galaxies are related with the A+em and SF galaxies. The A+em galaxies can be related with dust-obscureced galaxies Poggianti et al. (1999) or related with the AGN in theirs nucleus. There is no galaxies in SSB. On the other hand, fig. 4 reveals some inconsistencies regarding the color of galaxies and the spectral classification according to the D4000 vs Hδ. This is particularly noticeable in galaxies classified as passive, which exhibit a very blue color. Additionally, it is expected by definition that rHDS galaxies are noticeably redder than bHDS galaxies. However, despite the presence of a slight trend in this behavior, there are also certain galaxies strongly blue in the rHDS zone and galaxies at the boundary between red and blue in the bHDS zone.

3.4 D4000 vs O[II]

Following the figure 4, we made the same plane using the data of the O[II] vs D4000 in the figure 5. Is natural think that the relation of the O[II] with the D4000 represent a proxy of the star formation history and the age of the stellar populations. We put the EW[OII] axis in logarithm to have a better visualization of the features. We can see a clear tendence for the blue galaxies to put in the top of the data, and the some red galaxies maybe dust-obscureced (Poggianti et al. (1999)). The red galaxies falling to the bottom of the data, and we can put a line to separete them (**??**)

REFERENCES

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Poggianti B. M., Smail I., Dressler A., Couch W. J., Barger A. J., Butcher H., Ellis R. S., Oemler Augustus J., 1999, ApJ, 518, 576

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