zCOSMOS 20k sample

A (very short) journey through the survey's galaxy parameter data

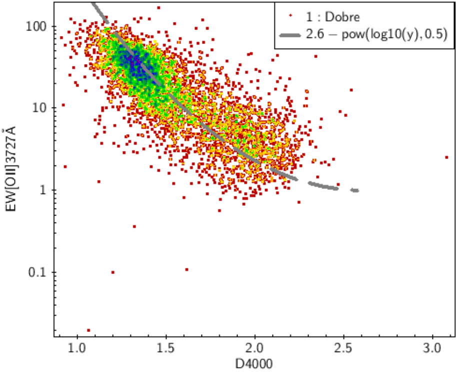
zCOSMOS survey

- zCOSMOS: a deep ESO redshift survey
  - area: $\sim$ 2 square deg around 10 h RA and 2° Dec (J2000)
  - goal: to obtain spectra of $\sim$ 28 000 galaxies, $I_{AB} < 22.5$, $0.2 < z \leq 1.2$, and $\sim$ 12 000 galaxies, $1.2 < z \leq 3$, $B_{AB} \leq 25$ (Lilly, S. et al. 2007, ApJS, 172, 7 & Lilly, S. et al. 2009, ApJS, 184, 218)
  - Availability of Hubble Space Telescope's (HST) Advanced Camera for Surveys (ACS) imaging (COSMOS survey; Scoville, N. et al. 2007, ApJS, 172, 1)
- The final dataset of $\sim$ 20 000 galaxies- public release expected to occur soon, we are using it in collaboration with dr Marco Scodeggio from INAF/IASF (Italy)

Spectroscopic classification; square root attempt

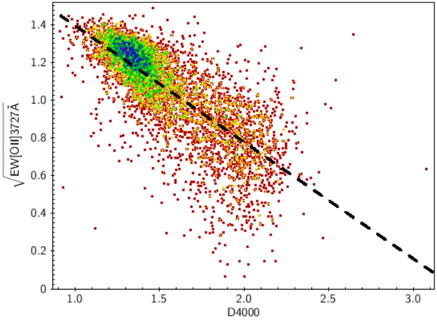
- D4000-EW[OII]λ3727 classification plane, after spectra quality preselection; a galaxy cloud $\sim$ 5000 galaxies, $0.45 \leq z \leq 1.25$:
- Two characteristics
  1. Continous
  2. Slightly curved
- The idea: straight it out. The first concept: a square root.
- The relation between D4000 and [OII]3727 Equivalent Width assumed in a form:

$$\sqrt{\log EW[OII]3727\lambda} = a \times D4000 + b \quad (1)$$



Density plot of D4000 vs EW[OII] 3727 Å spectral clasification plane with square root function plotted.

We can transform the [OII]-associated variable and obtain a figure as below:



Plot of D4000 vs $\sqrt{\log EW[OII]3727}$ with linear regression line

Relation much more linear, even if with some "hair" remaining

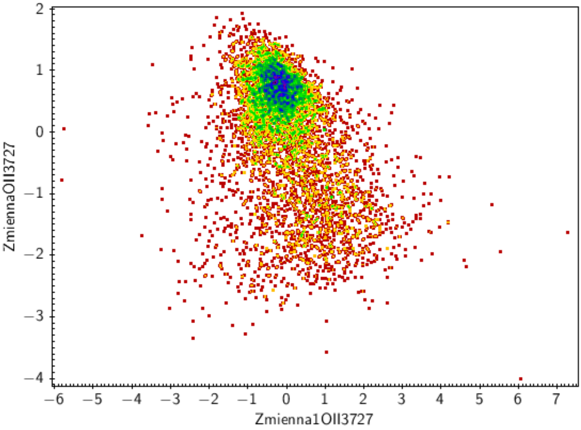
$$\sqrt{\log EW[OII]3727\lambda} = -0.980(10) \times D4000 + 2.573(11) \qquad (2)$$

Based on regression parameters, we can transform our D4000 and $\log EW[OII]3727\lambda$ variables into orthogonal normal variables along and across regression line. The new normal coordinates *Zmienna* and *Zmienna*1 are:

$$ZmiennaOII3727 = \frac{\frac{1}{0.93215} \times \sqrt{\log EW[OII]3727\lambda} + D4000 + 0.379841}{0.504047} \quad (3)$$

$$Zmienna1OIII3727 = \frac{0.93215 \times \sqrt{\log EW[OII]3727\lambda} + D4000 - 2.52322}{0.189564} \quad (4)$$

The classification plane in new normalised variables:



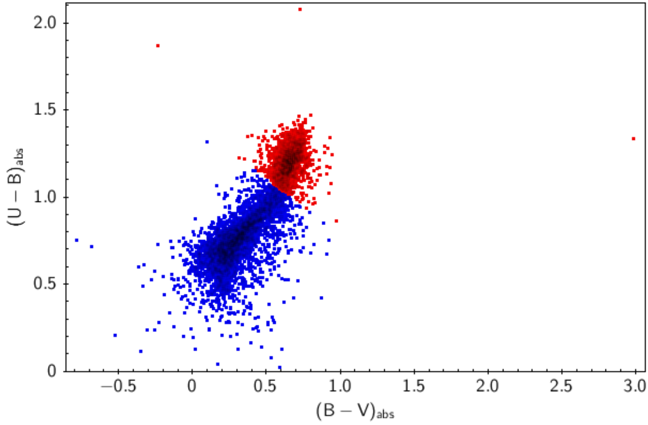
In the new variables there is a main pillar of galaxies in almost vertical direction. Almost -because linear fitting is not perfect and prone to errors due to the outliers and much wider distribution down the pillar.

Color analysis

The criteria of color segregation are borrowed from Krywult, J., et al. 2016 (preprint). There a new variable UBV was introduced, based on rest-frame U-B and B-V colors. It was defined as follows:

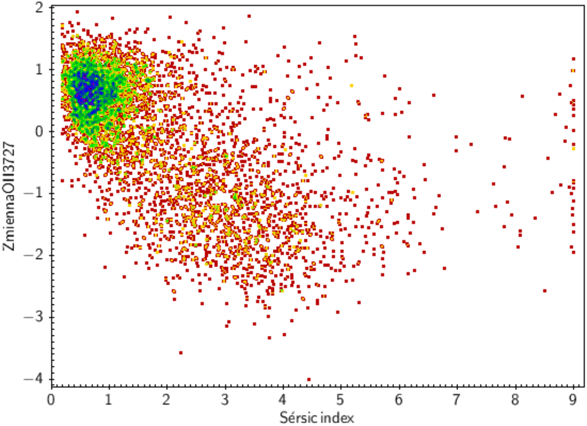
$$UBV = (B - V) \times \cos(\theta) - (U - B) \times \sin(\theta) \tag{5}$$

with $\theta = 58.08^{\circ}$, as obtained from the analysis of VIPERs data.



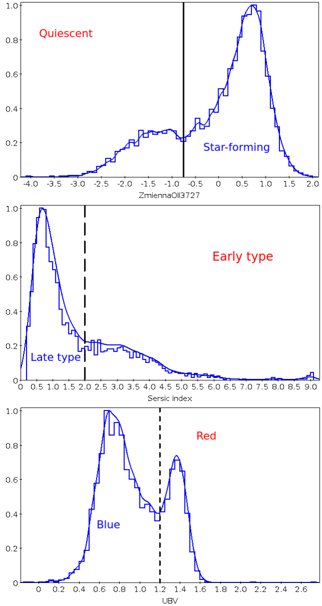
U-B vs B-V plane with two main classes defined according to the Krywult 2016 criteria criteria.

Comparison with Sérsic index



The distribution of the galaxies on plane combining the ZmiennaOII3727 star-formation variable with a Sérsic index.

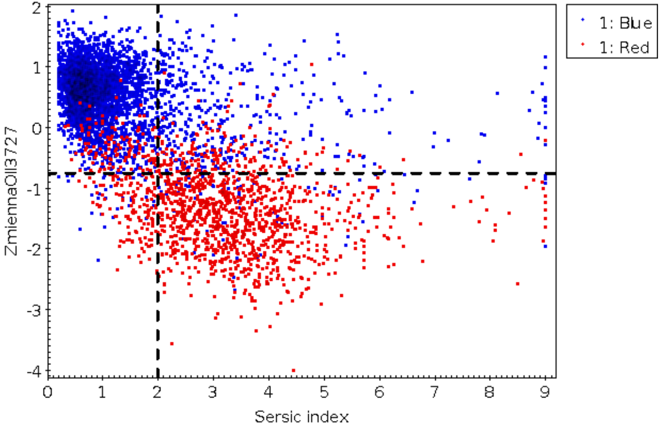
Bimodality in spectroscopic parameters, morphology and colors



From top to bottom:

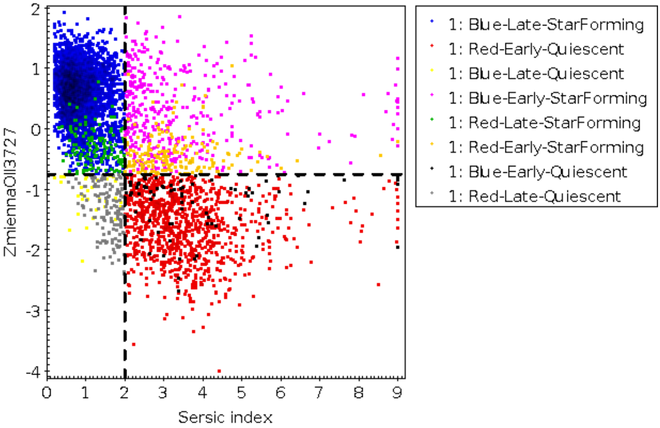
- ZmiennaOII3727 bimodality distribution (histogram and gaussian smoothen distribution) with a separation value of -0.75 marked. Galaxies with lower values are classified as spectroscopically quiescent while those with higher values as spectroscopically star-forming.
- Sersic index distribution with a critical value of 2 adopted (dashed line).
- UBV bimodality distribution (histogram and gaussian smoothen distribution) with a critical value of 1.2 marked by a dash line.

3D: Spectroscopy-color-Sérsic index



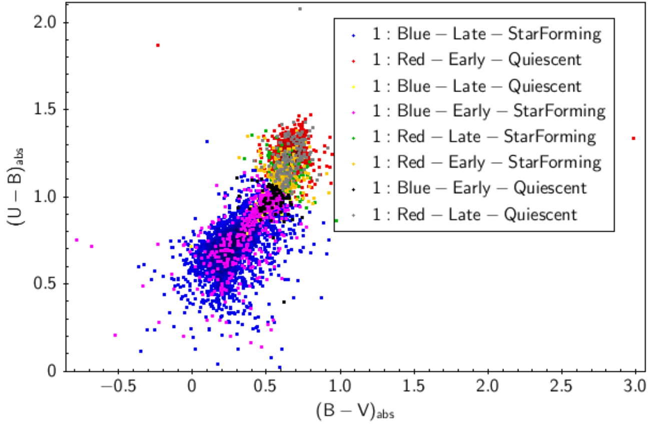
All three classifications (color, spectroscopy, morphology) on a single plot.

3D: Spectroscopy-color-Sérsicindex -main classes and outliers



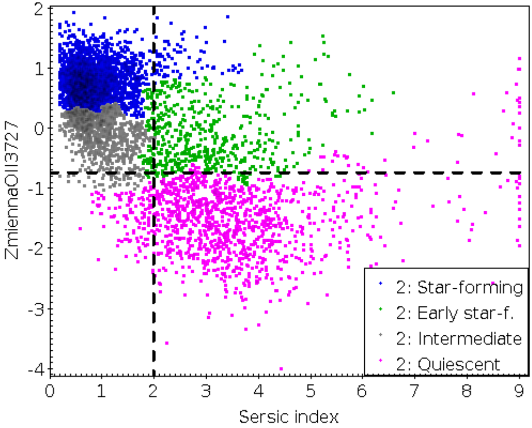
The distribution of the galaxies with concordant classifications in all three aspects (color, spectroscopy, morphology) and outliers in one of those categories.

3D: Spectroscopy-color-Sérsic index



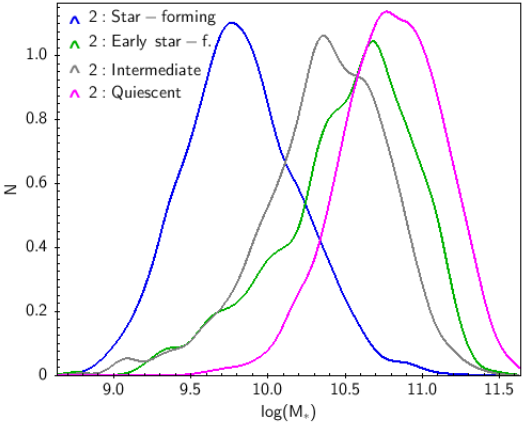
The U-B vs B-V plot of galaxy classifications.

Results of hierarchical cluster analysis (Ward's method)



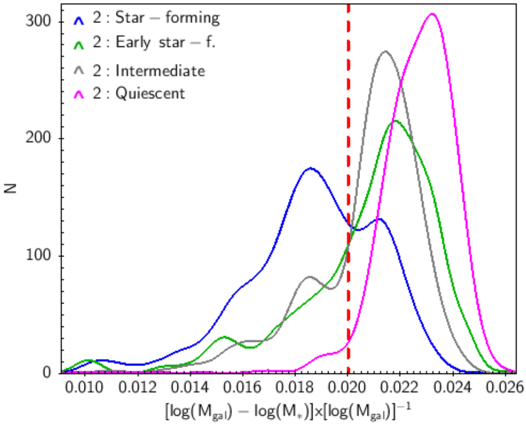
The four main groups returned as a result of Ward's hierarchical clustering algorithm applied to the galaxy cloud. Their locations correspond closely to the specified bimodalities.

Stellar mass dependence



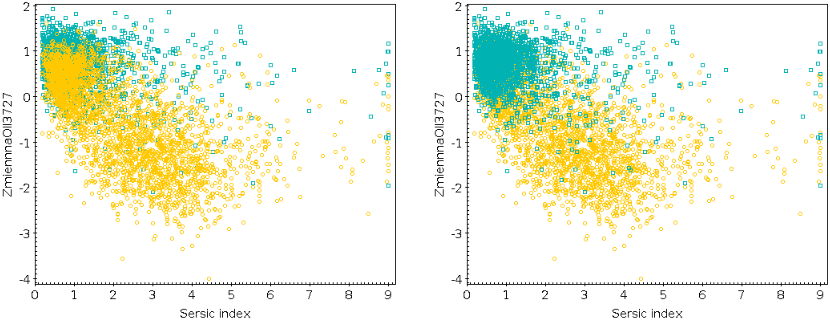
The distribution of stellar masses among four main groups resulting form hierarchical clustering. A gaussian smooth is applied.

Stellar mass vs galaxy baryonic mass ratio



The distribution of normalised difference between galxy baryonic mass and stellar mass among four main groups resulting form hierarchical clustering. A gaussian smooth is applied.

Stellar mass vs galaxy baryonic mass ratio



Galaxies with $[\log(M_{gal}) - \log(M_*)]x[\log(M_{gal})]^{-1}$ above the value of 0.020 (yellow circles) or below (blue squares). Two plots show overlaying of both groups in the star-forming region in top-left corner.

Hypotheses

- Galaxies obviuosly evolve towards higher stellar masses.
- Small galaxies below 10^{10} solar masses are star forming in the top left corner of ZmiennaOII3727 vs Sersic plane. Large galaxies above 10^{11} solar masses are largely evolved in right bottom regions of the plane
- Galaxies can evolve out of Great Plains in two directions: either to the right towards high Sersic indices with high ZmiennaOII3727 parameter, or down, through Intermediate's population locus (low Sersics, low values of ZmiennaOII3727, indicating relative passiveness), towards plateu of evolved galaxies in right bottom corner. Smaller galaxies sometimes go east, larger galaxies almost exclusively go south the chart.

Hypotheses continued

- There must be a decision point somewhere in the vicinity of 10^{10} solar masses.
- Physical interpretation is that while smaller galaxies must be still active in their bright cores, to go East, in those galaxies going south, the star formation activity needs to be relatively uniform along the radius, vanishing steadily.
- Could it be related to the burstiness of low mass galaxies (see recent paper by Guo, Y., et al. 2016, preprint)?