

## Introduction

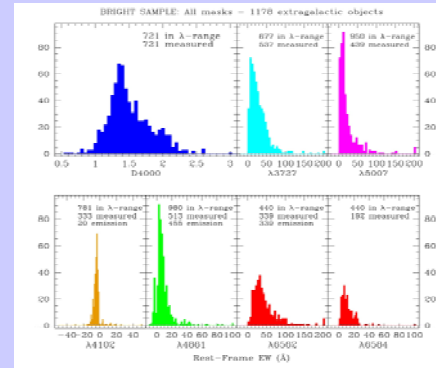
zCOSMOS is a massive redshift survey that is being undertaken in the COSMOS field as ESO Large Programme (~600 hours of observation) with the VIMOS spectrograph at the VLT. The survey consists of two parts: the first is a *I*-band magnitude limited sample selected from ACS images to have  $I_{AB} < 22.5$  and observed at medium resolution; this will yield spectra and redshifts of ~20,000 galaxies up to  $z \sim 1.5$  over two square degrees. The second and deeper part of the survey aims to obtain redshifts of ~12,000 galaxies with  $1.4 < z < 2.5$  at lower resolution and over the central square degree, selecting these objects through the application of two complementary color-selection criteria.

Here we present the result of the analysis of ~1200 galaxy spectra obtained during the first year of observations, a representative sample of the bright component of the full survey. The study includes: 1) the measurements of equivalent widths and fluxes of the main optical spectral lines and of the D4000 continuum index; 2) the classification of the galaxy spectra adopting a simple parametric recipe which uses only line equivalent widths and continuum indices; 3) the comparison between the spectral and photometric classifications, a first step toward the definition of the “classification cube” (spectra, colors, morphology).

## 1) Spectral Measurements

We performed the measurements on the spectra of all the extragalactic objects obtained during the first-year observations for the zCOSMOS Bright survey. In total 1178 galaxies (and QSOs) with a redshift determination have been examined. The measurement of the spectral quantities was performed using semi-automatic procedures which exploited the IRAF task *splot*: first, the continuum was automatically fitted in fixed spectral ranges, but the procedures also allow interactive adjustments of the continuum level in order to improve the line measurement in noisy spectra. Then, equivalent widths (EWs) and fluxes were measured using both a Gaussian fitting algorithm and direct integration of the continuum-subtracted line profiles. The fluxes measured with the two techniques are in excellent agreement: in all the emission lines the two values agree to within 25%, while the 1- $\sigma$  of the difference distribution is only 11%.

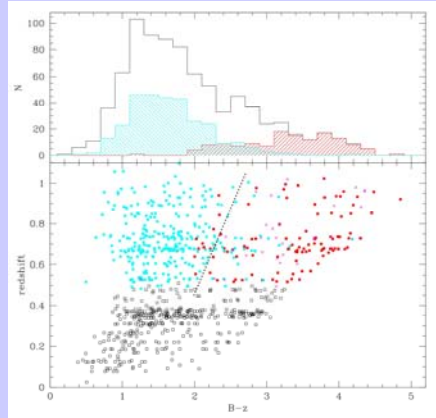
We measured EWs and fluxes for [OII]3727, H $\delta$ , H $\beta$ , [OIII]5007, H $\alpha$  and [NII]6583, as well as the strength of the 4000 Å break (D4000; Bruzual, '83).



**Figure 1:** Rest-frame measurement distributions of the analyzed spectral features. In each panel we also indicate the number of galaxies for which the feature is within the spectral observed range and the number of really detected lines. Only the H $\delta$  and H $\beta$  lines have been measured both in emission and absorption.

## 3) Colors vs. Spectral Classification

We analyzed all the possible photometric colors looking for a good photometric separation between spectral galaxy classes. The *B-z* color shows the best behaviour.



**Figure 3:** The *B-z* color distribution (upper panel); hatched cyan histogram for blue star-forming, red histogram for early-type galaxies, both with and w/o emission lines, shows a fairly good separation in the color of the different spectral classes, with however some overlap for  $2.0 < B-z < 3$ . The *B-z* vs. redshift plot (lower panel); cyan and red squares for star-forming and early-type galaxies respectively, magenta crosses for intermediate ones) exhibits an even more clear segregation of the galaxy classes.

Looking at the *B-z* vs. redshift plot, a few comments can be made:

- Galaxies of the intermediate class have a *B-z* colors which are similar to that of early-type galaxies; merging together these two classes and adopting the separation highlighted in figure by the dotted line, we derive the following 2x2 contingency table:

B-z	Spectral classification	
	Early	Starforming
Red	122	32
Blue	12	268

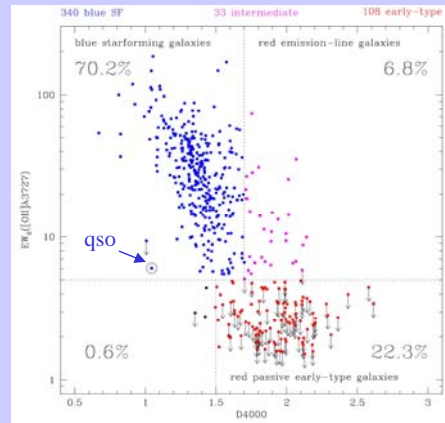
The two classification schemes (colors and spectral) are very well correlated, with a Pearson correlation coefficient ~ 0.78.

- Summarizing how the different galaxy populations inhabit the color versus spectral classification plane:

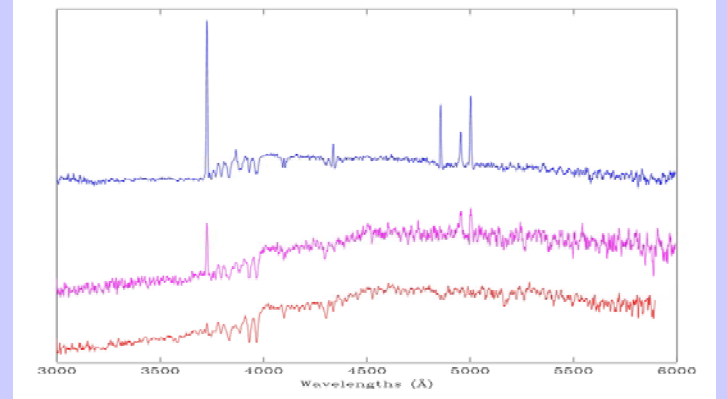
- 91% of objects spectroscopically classified as *early* from the spectra are red;
  - 89% of objects spectroscopically classified as *starforming* from the spectra are blue;
  - 79% of objects with red colors are *early* from the spectra;
  - 96% of objects with blue colors are *starforming* from the spectra;
- The worst correspondence is for the ~20% of red objects which are spectrally classified as “starforming”. The nature of these objects has to be better investigated (are they red because of dust?). The figure suggests that most of these objects are in redshift peaks (correlation between objects in this class and galaxy density?).

## 2) Spectral Classification

Following Mignoli et al. (2005, A&A 437), we applied the simple spectral classification scheme adopted for the *K20* survey, using the equivalent width of the [OII]3727 line and the 4000Å break index to define three main classes: red early-type galaxies, blue emission-line galaxies and the intermediate galaxies, which show emission lines but a red continuum, as indicated by the large value of D4000.



**Figure 2:** The classification plane for the high-quality ranked zCOSMOS galaxies, which highlights the efficiency of the adopted spectral classification scheme: only three objects marginally fall in the lower left “avoidance” region, whereas the class of red emission line galaxies includes only 7% of the sample. The adopted spectral range allows to apply this spectral classification only to those galaxies with sufficiently high redshift ( $z \sim 0.45-1.25$ ) to include the [OII]3727-D4000 region.



**Figure 4:** Composite spectra of the three main galaxy classes as defined following the scheme above. From bottom to top: 108 red passive early-type, 33 intermediate and 340 blue star-forming galaxies contribute to the averages. The continuum in the composite of the emission-line galaxies with red D4000 is largely indistinguishable from that of the purely passive galaxies, suggesting that the class of intermediate objects should be mainly composed of early-type galaxies undergoing a modest star-formation episode rather than of heavily reddened star-forming galaxies. The presence of the [OIII] emission doublet in the intermediate composite could witness some AGN (type 2) contamination in this galaxy class.

## Conclusions & Future Perspective

- The results presented here constitute a preliminary study of the potentialities offered by the zCosmos Bright galaxy sample. From our analysis, it is evident that the combination of medium spectral resolution, relatively good S/N spectra, automatic but efficient data reduction and successful redshift identification process, renders the zCosmos survey an ideal tool to investigate the spectroscopic properties of the extragalactic population. Both the analysis of the single galaxies (spectral parameters distributions, classification diagrams, metallicity, see Poster #34 by C.Maier) and the study of the high S/N composite spectra can be exploited to investigate the evolution of the spectroscopic properties in the galaxy population.
- This exploratory work comparing the different galaxy classification schemes appears very promising for the zCosmos Bright sample, and will show its full potentiality when also the third dimension (the ACS morphology) will be added to the “classification cube”. Furthermore, when the full final sample of ~12000 galaxies will be available, it will provide a unique tool to explore the behaviors of the different classification schemes both in the field and within the groups/clusters, to investigate their dependence on redshift and luminosity and to study the nature of the “outliers”, i.e. galaxies without concordance in the spectral/photometric/morphological characteristics.