Galaxy morphology at $0.5 < z < 1.0$ with VIPERS

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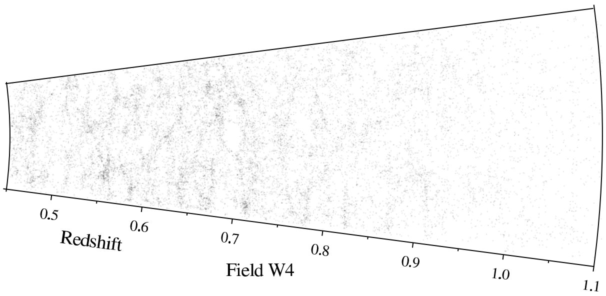
Abstract

We present the results of our analysis of morphological properties of VIPERS galaxies in the redshift range $0.5 < z < 1.0$. The structural parameters of galaxies were obtained by fitting the Sersic profiles to the CCD images coming from the CFHTLS survey. Using multi-band photometry and Sersic parameters we divided galaxies into the rest-frame colour population. We analyze each galaxy sample and discuss possible physical correlation between Sersic parameters of galaxies and their colours and other properties like luminosities and stellar masses, and we follow the redshift evolution of these relations.



Data

The data used in the analysis are derived from the VIPERS PDR-1 catalogue (Garilli et al. 2013). The VIMOS Public Extragalactic Redshift Survey is an ongoing ESO large program to map in detail the spatial distribution of $\sim 100,000$ galaxies at redshift $0.5 \leq z \leq 1.2$ and $i_{AB} < 22.5$ (Guzzo et al. 2013). From the first-epoch spectroscopic measurements of $\sim 57,000$ galaxies we selected only objects with good quality of redshift estimation, i.e. flag=2,3,4,9 (Le Fevre et al. 2003). Sersic profile parameters of galaxies were obtained from $i-$band CCD images taken from CFHTLS (Gonarova et al. 2009).

Methods

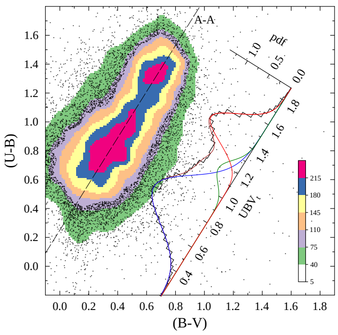


Fig. 1. $(U-B)$ vs. $(B-V)$ density plot of galaxies and the histogram constructed along the A-A line connecting two maxima.

1) The absolute magnitudes (Fritz et al. 2014) were corrected for the evolution of the luminosity function of galaxies using the Schechter function parameters (Ilbert et al. 2005). The analysis was carried out in the volume limited sample of galaxies in the $0.5 \leq z \leq 0.95$ and $B - B_* = [-1.0, 1.0]$.

2) In order to classify the galaxies into the rest-frame colour populations we apply the $(U-B)$ versus $(B-V)$ colour diagram presented in Figure 1. It shows two clear visible maxima corresponding to the early and late-type galaxy population. The region between them, the green valley, is dominated by the intermediate objects. In the following analysis we transformed the $U-B$ and $B-V$ colour into UBV_t rest-frame colour computed along the line AA crossing two density maxima. This line corresponds to the evolution track of galaxies from the blue cloud to the red sequence (Vazquez & Leitherer 2005).

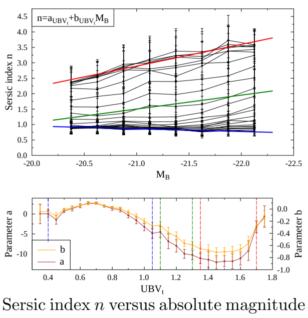
3) The analysis was carried out on the 30 rest-frame colour bins uniformly covering the UBV_t colour range from 0.3 to 1.8 mag. In each colour bin the corresponding relation is approximated by the straight line $y = a + b \cdot x$.

4) To approximate observed galaxy shapes we used the single component Sersic (1968) profile given by

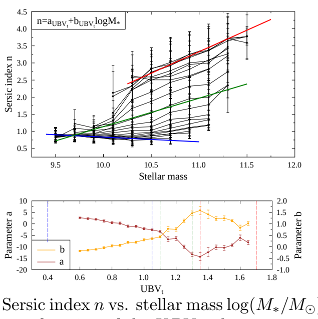
$$I(r) = I_e \exp\left[-b_n\left(\left(\frac{r}{r_e}\right)^{1/n} - 1\right)\right]$$

where I_e is the luminosity within the effective radius r_e which encloses half of the total galaxy light, n is the shape parameter and the factor b_n varies with n. We have chosen the GALFIT (Peng 2002) code to estimate the Sersic profile parameters from the $i-$band CCD images (Krywult et al. 2015). The Point Spread Function was approximated by the elliptical Moffat (1969) function in each of 28 $1^o \times 1^o$ CCD field of CFHTLS. The GALFIT results were tested on the 4000 artificially generated galaxy images and show a good agreement between value of the input and output Sersic parameters.

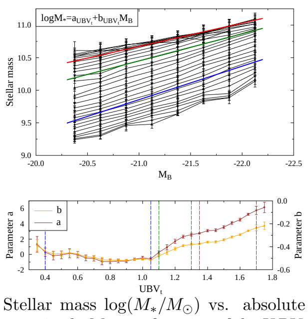
Results



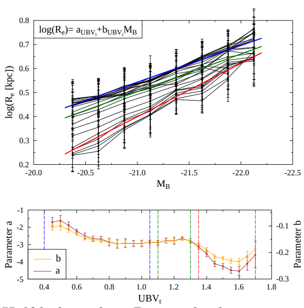
Sersic index n versus absolute magnitude M_B as a function of the UBV_t colour.



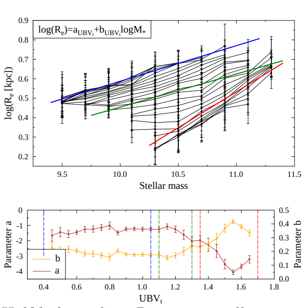
Sersic index n vs. stellar mass $\log(M_*/M_\odot)$ as a function of the UBV_t colour.



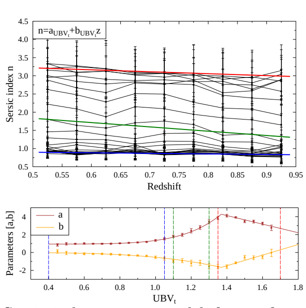
Stellar mass $\log(M_*/M_\odot)$ vs. absolute magnitude M_B as a function of the UBV_t.



Half-light radius R_e vs. absolute magnitude M_B as a function of the UBV_t.



Half-light radius R_e versus stellar mass $\log(M_*/M_\odot)$ as a function of the UBV_t.



Sersic index n versus redshift as a function of the UBV_t colour.

Fig. 2. Correlation between investigated galaxy parameters (Sersic index, size, stellar mass, absolute magnitude and redshift) as a function of the UBV_t rest-frame colour. The red, green and blue lines show the relation for galaxies located in the middle of the blue, green and red galaxy population. Parameters a and b of the fitted relations are presented below each plot.

Conclusions

- Sersic profiles of VIPERS galaxies were obtained from the i-band CFHTLS images for $\sim 50,000$ objects. The tests show that the computed profile parameters are robust.
- The method applied to colour-colour diagrams for galaxies allows for a good classification of objects into rest-frame colour subsamples.
- Sersic index for the blue galaxies is almost independent from luminosity. The $n(M_B)$ relation is systematically steeper for the green and red galaxies (McIntosh et al. 2005).
- Half-light radius R_e of the elliptical galaxies quickly increases with stellar mass (Shen et al. 2003) while the intermediate galaxies tend to be more similar to spirals. The stellar mass of the most massive, $\log(M_*/M_\odot) \approx 11.5$, elliptical and intermediate galaxies are almost equal.
- The value of n for the red galaxies decreases with look-back time which may be interpreted as their changing morphology with z (Patel et al. 2013). For the blue galaxies $n(z)$ is almost redshift independent, while for green galaxies this relation lies in between.
- Size and the stellar mass of the bright green and red galaxies is almost equal. The differences systematically increase for the less luminous objects.

References

Fritz, A. and the VIPERS Team 2014, A&A, 563, A96
Ilbert, O., et al. 2005, A&A, 439, 863
Le Fevre, O., et al. 2003, SPIE Conf. Ser. vol. 4841
Garilli, B. and the VIPERS Team 2014, A&A, 562, A23
Guzzo, G. and the VIPERS Team 2014, A&A, 566, A108
Gonarova, Y., et al. 2009, The CFHTLS T0006 Release
Krywult, J., and the VIPERS Team 2015, in preparation
McIntosh, D.H., et al. 2005, ApJ, 632, 191
Mendez, A.J., et al 2011, ApJ, 736, 110
Moffat A.F.J. 1969, A&A, 3, 455
Patel, S.G., et al. 2013, astro-ph/1208.0341
Peng, C.Y., et al. 2002, AJ, 124, 266
Sersic, J. 1968, Atlas de Galaxias Australes, Obs. Astronomico, Cordoba
Vazquez, G.A., Leitherer, C. 2005, ApJ, 621, 695
VIPERS web page: http://vipers.inaf.it

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