ENVIRONMENTAL PROPERTIES OF GALAXIES AT $Z < 0.1$ FROM THE SDSS VIA THE VORONOI TESSELLATION

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ABSTRACT. The aim of our work was to investigate the environmental density of galaxies from the SDSS DR9 at $z < 0.1$ using the 3D Voronoi tessellation. The inverse volume of the Voronoi cell was chosen as a parameter of local environmental density. We examined a density of given bright galaxy taking into account its faint satellites located in the Voronoi cell. We found that with the increase of total galaxy density around the central bright galaxy, the probability that it has the early type is increasing.

Key words: data analysis; surveys; galaxies.

1. Introduction

Many studies have confirmed that galaxy morphology and environment are correlated. The fraction of the early type galaxies is higher in regions with elevated concentrations of galaxies, while the late type galaxies predominate in the general field (Dressler 1980; Einasto et al. 2003, Blanton et al. 2005, Vavilova et al. 2009). However, the basic galaxy properties at first depend strongly on galaxy mass (nature) and then on their environments (nurture; Peng et al. 2010). In this work we examined an environmental density of galaxies from SDSS DR9 at $z < 0.1$ using 3D Voronoi tessellation (Melnyk et al. 2006; Elyiv et al. 2009; see, also, Kim et al. 2000; Ramella et al. 2001; Wilman et al. 2010; Way et al. 2011; Soares-Santos et al. 2011; Zaninetti 2012).

2. Sample and Method

The detail description of the studied galaxy sample was presented in Dobrycheva (2013). We note here that the initial sample included 724 000 objects from SDSS DR9 with $z < 0.1$. After the removing of stars and duplicates as well as applying the limits on redshift, $0.02 < z < 0.1$, and apparent magnitude, $m_r < 17.7$, the studied sample contains 260 000 galaxies.

The application of the Voronoi tessellation requires that the galaxy sample should be as much homogeneous as possible. By this reason we limited the

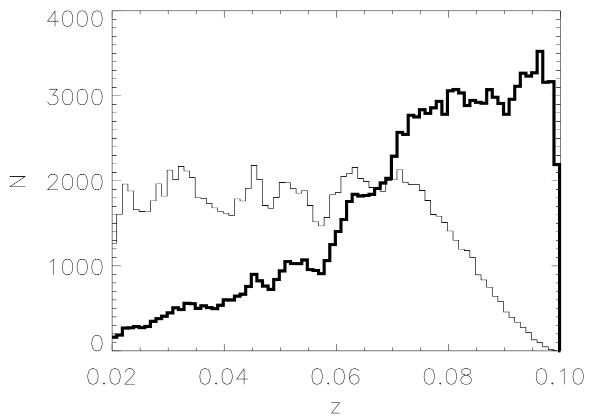

Figure 1: The redshift distribution for the central bright galaxies (thick line) and faint satellites (thin line).

SDSS sample by the absolute magnitude $M_r < -20.7$ ($N \sim 124000$). Then, for these bright central galaxies we applied 3D Voronoi tessellation method. We examined the properties of the environment near the central bright galaxies taking into account its faint satellite galaxies with $M_r > -20.7$ ($N \sim 136000$). Their distributions by z are shown in Fig. 1.

The absolute galaxy magnitude was corrected for the Galactic absorption *ext* by Schlegel et al. (1998) and K-correction $K(z)$ according to Chilingarian (2010): $M_r = m_r - 5 * log(V/H_0) - 25 - K(z) - ext$. We characterised the local environment density of galaxies by the inverse value of the Voronoi cell volume: $N = (n+1)/V$, where $n+1$ is the total number of galaxies (n faint and 1 bright galaxies) inside the Voronoi cell having the volume V. All galaxies from the studied sample were morphologically classified according to the criteria proposed by Melnyk et al. (2012) using the colors $(g - i)$ and inverse concentration $R50/R90$ indices.

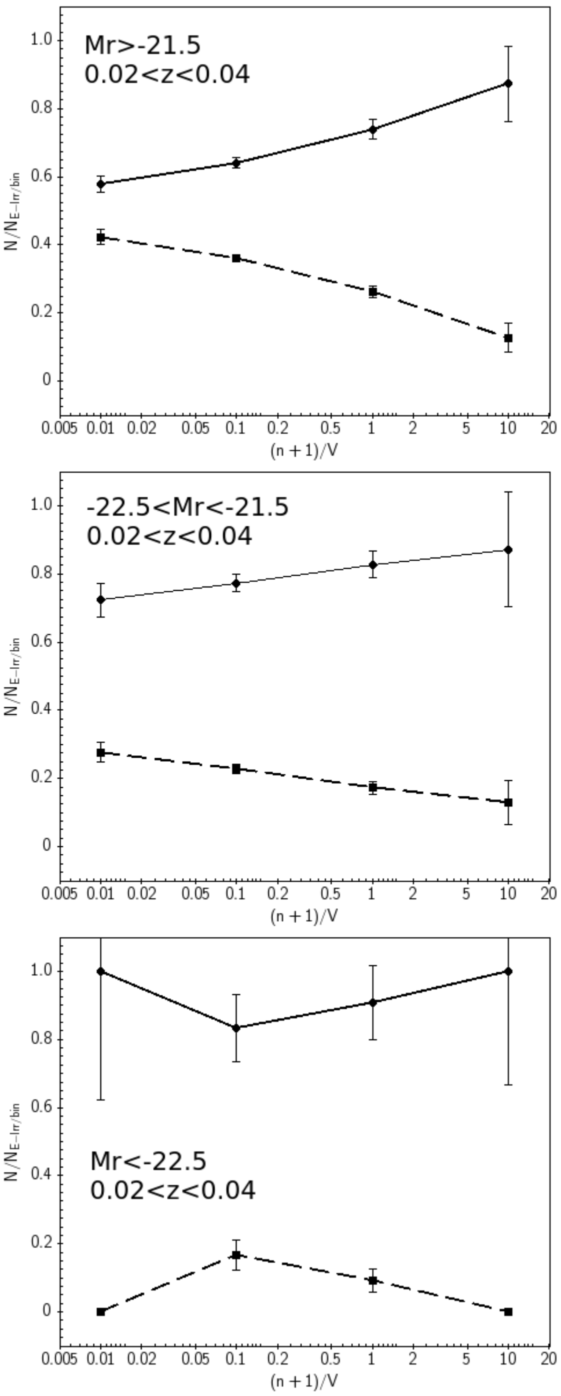

Figure 2: Distribution of galaxies according to their environmental density in the Voronoi cells: $(n+1)/V$, where n is the number of faint satellite galaxies with $M_r > -20.7$, V is the volume of Voronoi cell. Types of $E-S0$ (solid line) and $Sa-Irr$ (dotted line) correspond to the central bright galaxies, which are the nuclei of the corresponding Voronoi cells. Number of galaxies in each bin is normalized by the total number of central bright galaxies $E-Irr$ in the corresponding bin $(n+1)/V$. The absolute magnitude ranges noted in the figures correspond to the central bright galaxies.

3. Results

Fig. 2 shows the distribution of the early $E-S0$ (solid line) and $Sa-Irr$ (dashed line) type central bright galaxies by the inverse value of the Voronoi cell volume in four intervals: $(n+1)/V < 0.01$, $0.01 < (n+1)/V < 0.1$, $0.1 < (n+1)/V < 1$, $(n+1)/V > 1$. The number of galaxies is normalized to the total number of galaxies $E-Irr$ in the sample in the corresponding range of $(n+1)/V$. We were able to analyse the environmental density of galaxies only in the $0.02 < z < 0.04$ interval because of the number of faint galaxies are dramatically decreases with z (Fig. 1). Namely, we clearly see in Fig. 2 that with increasing the environmental density, the proportion of the early type central galaxies is increasing, while the proportion of the late type galaxies is decreasing.

It allows to conclude that the early type galaxies are located in denser environments than the late type galaxies; moreover, the brighter the central galaxies, the greater the proportion of early types in the subsample. The detailed comparison of the environmental density of galaxies versus the magnitude, color, and morphological type of the central bright galaxy is presented in Dobrycheva et al. (2015).

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