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ENVIRONMENTAL DEPENDENCE OF FIVE PHOTOMETRIC BAND STRUCTURAL PARAMETERS OF MAIN GALAXIES

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Using two volume-limited Main galaxy samples of the Sloan Digital Sky Survey Data Release 7 above and below the value of M_r^* , we explore the environmental dependence of five photometric band concentration indexes. It is found that all the five band concentration indexes strongly correlate with local environment for all galaxies above and below the value of M_r^* : high concentration galaxies exist preferentially in high density regions, while low concentration galaxies are located preferentially in low density regions.

Key words: galaxies: fundamental parameters: statistics

1. Introduction. In the past, some works shed light on the correlation between galaxy structural parameters and environment [1-8]. Kauffmann et al. [1] reported that at fixed stellar mass structural parameters are almost independent of the local density. Van der Wel [4] demonstrated that the galaxy structure is very strongly correlated with stellar mass while the galaxy morphology is sensitive to environment. Van der Wel argued that this is driven by variations in star formation activity, as traced by color, which only exert the weak influence on the structure of a galaxy but strongly affects its morphological appearance. In the Main galaxy sample [9] of the SDSS, Deng et al. [5] concluded that high concentration galaxies tend to reside in high density regions, while low concentration galaxies tend to reside in low density regions. Deng et al. [8] found that the size of High Stellar Mass (HSM) and Low Stellar Mass (LSM) galaxies is weakly correlated with environment, which is likely due to galaxy size being insensitive to environment (Deng et al. [5]).

When exploring the environmental dependence of galaxy luminosity in the SDSS galaxy samples, some works focused on the environmental dependence of all the five band luminosities. Deng & Zou [10], Deng [11] and Deng et al. [12,13] demonstrated that in the SDSS Main galaxy sample [9], the environmental dependence of galaxy luminosity likely has different trends in different bands: the widely accepted trend of the luminosity-density relation (e.g., [5,6,14-19]) can be observed for r, i and z bands, but for u-band the luminosity-density relation has an opposite trend. Deng et al. [13] used two

volume-limited samples above and below the value of M_r^* and found that in the luminous volume-limited sample, all the five band luminosity strongly correlate with local environment; in the faint volume-limited sample, the *u*-band luminosity of galaxies still strongly depends on local environment, but the *r*, *i* and *z* band luminosity only is a weak function of local environment. These results show that for different photometric bands, environmental dependence of galaxy properties likely is different. Deng et al. [6] only studied the environmental dependence of *r*-band concentration index. We believe that the environmental dependence of other band concentration indexes also merits further investigation.

Our paper is organized as follows. In section 2, we describe the data used. The environmental dependence of u, g, r, i and z band concentration indexes for galaxies above and below the value of M_r^* is discussed in section 3. Our main results and conclusions are summarized in section 4.

In calculating distances we used a cosmological model with matter density $\Omega_0 = 0.3$, cosmological constant $\Omega_A = 0.7$ and Hubble's constant $H_0 = 70$ km s⁻¹ Mpc⁻¹.

2. Data. Stoughton et al. [20] discussed in detail many survey properties of the SDSS. Galaxy spectroscopic targets were selected by two algorithms. The Main galaxy sample [9] comprises galaxies brighter than $r_{perro} = 17.77$ (*r*-band apparent Petrosian magnitude). The Luminous Red Galaxy (LRG) algorithm (Eisenstein et al. [21]) selects galaxies to $r_{perro} < 19.5$ that are likely to be luminous early-types, based on the observed colors.

In this work, we use two volume-limited Main galaxy sample of the SDSS DR7 (Abazajian et al. [22]) above and below the value of M_r^* constructed by Deng [23]. The luminous volume-limited Main galaxy sample contains 120362 galaxies at $0.05 \le z \le 0.102$ with $-22.5 \le M_r \le -20.5$. The faint volume-limited sample contains 33249 galaxies at $0.02 \le z \le 0.0436$ with $-20.5 \le M_r \le -18.5$.

3. The environmental dependence of five photometric band concentration indexes. Following Deng et al. [19], we compute the local three-dimensional galaxy density in a comoving sphere with a radius of the distance to the 5th nearest galaxy for each galaxy, and arrange galaxies in a density order from the smallest to the largest. For each sample, we select approximately 5% of the galaxies, construct two subsamples at both extremes of density according to the density, and compare distributions of five photometric band concentration indexes of galaxies in the lowest density regime with those of galaxies in the densest regime.

In this study, we use the concentration indexes of $ci = R_{90}/R_{50}$ as a structural parameters. Fig.1-5 show distributions of five photometric band concentration indexes of two subsamples at both extremes of density for the faint and luminous volume-limited samples. As seen from these figures, in the faint and

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luminous volume-limited samples, all the five band concentration indexes strongly correlate with local environment: high concentration galaxies exist preferentially in high density regions, while low concentration galaxies are located preferentially in low density regions, which is consistent with results of the Luminous Red Galaxy (LRG) sample obtained by Deng & Zou [8]. Some authors showed deep concern over the deviant behavior of the *u*-band statistical results (e.g., Deng & Zou [8,10]; Deng [11]). For example, Deng & Zou [8] demonstrated that the environmental dependence of *u*-band concentration index is much stronger than the one of other band concentration indexes and argued that the deviant behavior of the *u*-band concentration index may be due to measurement errors on low S/N (signal-to-noise ratio) data. Deng & Zou [10] and Deng [11] found the abnormal environmental dependence of *u*-band luminosity: faint galaxies tend to reside in high density regions, while



Fig.1. *u*-band concentration index distribution at both extremes of three-dimensional density for the faint (left panel) and luminous (right panel) volume-limited samples: solid line for the subsample at high density, dashed line for the subsample at low density. The error bars of dashed lines are 1 or Poissonian errors. Error-bars of solid lines are omitted for clarity.





luminous galaxies tend to reside in low density regions, which likely is due to larger u-band Petrosian flux errors. Here, we do not observe the deviant



Fig.3. As Fig.1 but for r-band concentration index distribution.







Fig.5. As Fig.1 but for z-band concentration index distribution.

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behavior of the environmental dependence of u-band concentration index.

Deng et al. [6] demonstrated that r-band luminosity strongly depend on local environments only for galaxies above M_r^* , but this dependence is very weak for galaxies below M_r^* . They noted that g-r color, r-band concentration index ci and galaxy morphologies strongly depend on local environments for all galaxies with different luminosities, which shows that M_r^* is an characteristic parameter only for the environmental dependence of galaxy luminosity. Deng et al. [13] also observed significant difference and even opposite trend between the faint and luminous volume-limited samples. In this work, we found that five band concentration indexes strongly depend on local environment for all galaxies above and below the value of M_r^* . This further shows that M_r^* is not an characteristic parameter for the environmental dependence of concentration indexes.

As is well-known, many properties of galaxies are closely correlated with luminosity [16,24-30]. The environmental dependence of concentration indexes is a single trend in different luminosity regions and for different bands, but this dependence of luminosity is not a single trend. This shows that the correlation between concentration indexes and luminosity is not tight.

4. Summary. Using two volume-limited Main galaxy sample of the SDSS DR7 (Abazajian et al. [22]) above and below the value of M_r^* constructed by Deng [23], we explore the environmental dependence of five photometric band concentration indexes. Like Deng et al. [19] did, we use the density estimator within the distance to the 5th nearest neighbor, and construct two subsamples at both extremes of density and compare distributions of five photometric band concentration indexes of galaxies between them for each volume-limited sample. It is found that five band concentration indexes strongly depend on local environment for all galaxies above and below the value of M_r^* : high concentration galaxies exist preferentially in high density regions, while low concentration galaxies are located preferentially in low density regions, which is consistent with results of the Luminous Red Galaxy (LRG) sample obtained by Deng & Zou [8].

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ЗАВИСИМОСТЬ ОТ ОКРУЖЕНИЯ СТРУКТУРНЫХ ПАРАМЕТРОВ ПЯТИ ФОТОМЕТРИЧЕСКИХ ПОЛОС ГЛАВНЫХ ГАЛАКТИК

ХИН-ФА ДЕНГ', ГУИШЕНГ Ю2

Используя две объемно-ограниченные группы Главных галактик из Sloan Digital Sky Survey Data Release 7 выше и ниже значения M_r^* , мы исследовали зависимость индексов концентрации пяти фотометрических полос от окружения. Найдено, что все пять индексов концентрации полос сильно коррелируют с местным окружением для всех галактик выше и ниже значения M_r^* : галактики с высокой концентрацией в основном находятся в областях высокой плотности, тогда как галактики с низкой концентрацией в основном находятся в областях низкой плотности.

Ключевые слова: галактики: основные параметры: статистика

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