Advances in Astronomy and Space Physics, **2**, 42-44 (2012)

Criteria for galaxy classification in SDSS

D. Dobrycheva[1]*, *O. Melnyk*[2,3]

[1]Chernigiv Shevchenko National Pedagogical University, Getmana Polubotka Str., 53, 14013, Chernigiv, Ukraine
[2]Astronomical Observatory, Taras Shevchenko National University of Kyiv, 3 Observatorna St., 04053, Kyiv, Ukraine
[3]Institut d'Astrophysique et de Géophysique, Université de Liège, 4000, Liège, Belgium

We considered the sample of galaxy pairs collected from SDSS DR5. At first we made a morphological classification of approximately 1100 galaxies by visual inspection. As it is known the galaxy morphological types strongly depend on the color indices, the concentration parameters, galaxy magnitudes, de Vaucouleurs and exponential fit scale radii. Thus we used pairs of these parameters and found the universal criteria which can be used for galaxy morphological classification with the help of our "by-eye" classification. According to our criteria we can select early type galaxies with 90% probability.

Key words: galaxies: evolution, interactions, fundamental parameters

INTRODUCTION

Morphology is one of the most important galaxy characteristics bacause it correlates with many other individual properties, namely mass, luminosity, color index, concentration index etc. [5]. Detailed study of morphological structure of such simple systems as pairs of galaxies is a necessary step in understanding the galaxy evolution because both galaxies of a pair are supposed to evolve simultaneously [2].

SAMPLE OF GALAXY PAIRS FROM SDSS DR5

In this work we considered a sample of galaxy pairs selected by the second-order Voronoi tessellation method, using the northern part of the Sloan Digital Sky Survey (SDSS) Data Release 5 (DR5) [1]. The detailed description of the sample was given in our previous papers [1, 3, 4, 6] where we presented some of the physical properties of selected isolated galaxies, pairs and triples. This sample contains 2198 galaxies in pairs with radial velocities from 3500 to 9500 km/s. We took 537 of them with the largest degree of isolation and then made the visual inspection of each pair. We found that 3 of our pairs are single galaxies and we excluded them from the analysis. We also excluded 168 pairs neighbouring to galaxies without redshifts or with close redshifts. Thus, the investigated sample consists of 365 galaxy pairs.

*dariadobrycheva@rambler.ru

MORPHOLOGICAL CLASSIFICATION OF GALAXIES

There are various classification schemes of SDSS galaxies. The simplest of them lies in subdivision of galaxies into early (so-called "red" sample) and late types (so-called "blue" sample). We used slightly modified de Vaucouleur's classification of galaxies as in the paper [6]: -2 – E, 0 – S0, 1 – Sa, 2 – Sab, 3 – Sb, 4 – Sbc, 5 – Sc, 6 – Scd, 7 – Sd, 8 – Sdm, 9 – Im/BCG, 10 – Irr.

CRITERIA FOR GALAXY CLASSIFICATION IN SDSS

We have built the dependence between the color index u-r, g-i, r-z and the inverse index of brightness concentration towards the galaxy centre R50/R90, de Vaucouleurs fit scale radius (deVRad_r), exponential fit scale radius (expRad_r) and also the absolute galaxy magnitude M_r (Fig. 1). Notations deVRad_r and expRad_r were taken from SDSS. In Fig. 1 one can see zones 1, 2 and 3 which contain the maximum number of galaxies of early (-2 – 0), spiral (1 – 6) and late (7 – 10) types correspondingly. The zones were chosen to make the color index criteria identical for four parameters and to allocate the early galaxy types as precise as possible.

So we identified early types (-2 – 0) and obtained a good correlation with all the parameters and color index: about 95% of these galaxies could be allocated

by our criterion. Meanwhile about 15-20% of spirals (1 – 6) are located in zone 3 and 20-25% in zone 1.

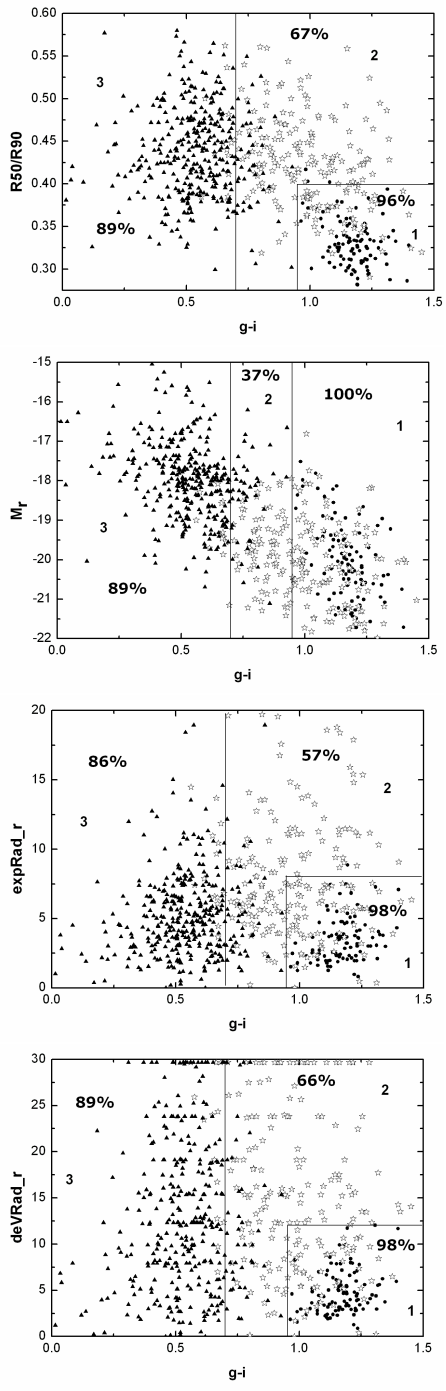

Fig. 1: The dependence of the color index on the inverse index of the brightness concentration towards the galaxy centre, absolute stellar magnitude, de Vaucouleurs fit scale radius and also the exponential fit scale radius. The galaxies of -2 and 0 morphological types are marked as circles, 1 – 6 with open stars, and 7 – 10 with triangles.

Our criterion works better for allocation of late spirals and irregular galaxies (7 – 10): near 90% of them are located in zone 3 and 5-15% in zone 2. The diagram for spiral galaxies selection works the worst: only 30% of these galaxies are located in the correspondent area. It should be stressed that the difference between spirals of types 6 and 7 was chosen not by chance. We searched the various options and chose the one in which the boundary between zones 2 and 3 would be the most explicit.

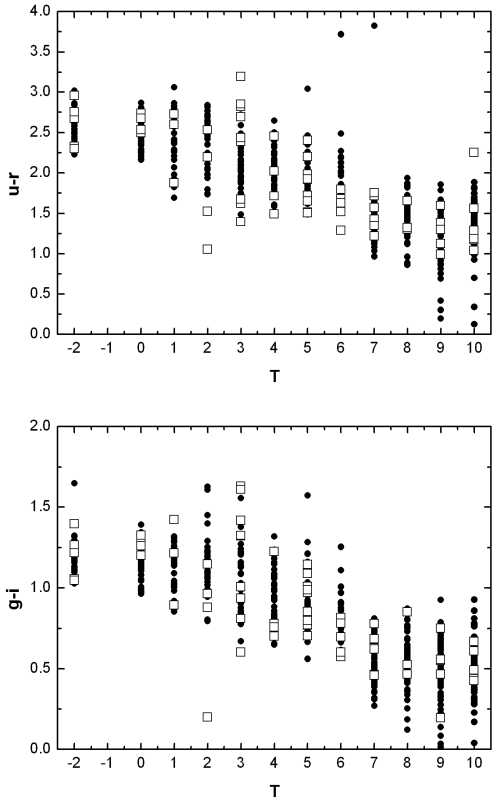

Fig. 2: Dependence of the color index on the morphological type of galaxies in pairs. Galaxies in isolated pairs are denoted with dark squares, interacting systems are denoted with white squares.

We have not just classified galaxies visually but also have shown the dependence of the morphology type on various parameters. Rough morphological classification without resorting to a visual rendering could be provided using one among the three color indices, namely the inverse concentration index, or the de Vaucouleurs fit scale radius or the absolute stellar magnitude. More than 90% of the galaxies of types -2 – 0 and 7 – 10 would be found in their zones. There are some difficulties with the galaxies of types 1 – 6 due to rather large overlap of types. This is obvious from Fig. 3 which shows the dependence of the morphological types of galaxies in the pairs on the color indices u-r and g-i. One can see that correlation with a morphological type remains

for interacting galaxies marked by the white squares as well.

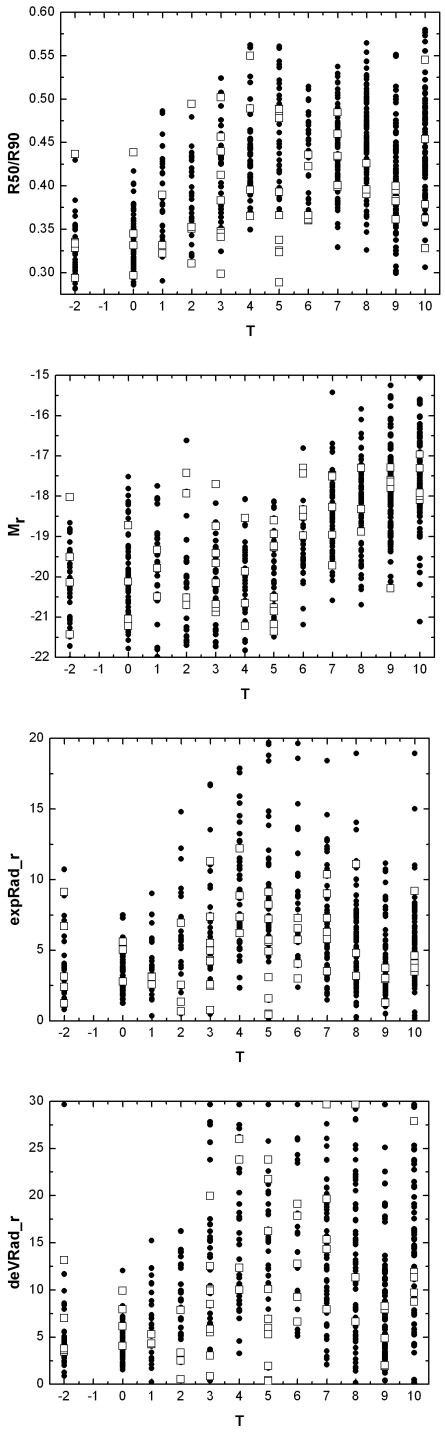

Fig. 3: Dependence of the inverse concentration index, absolute stellar magnitude, de Vaucouleurs fit scale radius and the scale radius on the morphological type of galaxies in pairs. Galaxies in isolated pairs are denoted with dark circles, interacting systems are denoted with white squares.

Comparing Fig. 2 and 3 we concluded that the correlation between a morphological type and the color indices is expressed the most. The correlation with the other parameters is weaker, while the spread of values is much greater.

CONCLUSIONS

1. Using a sample of 365 pairs of galaxies selected by the second-order Voronoi tessellation method [1] we have shown that the morphological types of galaxies correlate with color index better than with the inverse index of brightness concentration towards the galaxy centre R50/R90, de Vaucouleurs radius deVRad_r, the scale radius expRad_r, as well as with the absolute stellar magnitude.

2. With the help of visual classification of galaxies, we identified a possible criterion for the separation of galaxies into 3 types by using two-dimensional color-magnitude diagram, color-R50/R90, color-deVRad_r and color-expRad_r.

REFERENCES

[1] Elyiv A., Melnyk O. & Vavilova I. 2009, MNRAS, 394, 1409
[2] Karachentsev I. D. 1987, 'Double galaxies', Nauka, Moscow
[3] Melnyk O. V., Elyiv A. A. & Shihman V. L. 2009, Visnyk Kyivskogo Universytetu. Astronomia, 45, 24
[4] Melnik O. V., Elyiv A. A. & Vavilova I. B. 2009, Kinematika i Fizika Nebesnykh Tel, 25, 1, 64
[5] Park C. & Choi Y.-Y. 2005, ApJ, 635, L29
[6] Vavilova I. B., Melnyk O. V. & Elyiv A. A. 2009, Astron. Nachr., 330, 1004