Retarded Evolution of Low-Mass Galaxies in Voids?

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Introduction

Popular CDM models of the structure and galaxy formation predict that a fraction of low-mass galaxies in the regions of very low density of normal galaxies ('voids') form later and evolve more slowly (e.g., Benson et al. 2003; Gottlöber et al. 2003). In particular, a substantial part of low-mass galaxies populating in voids are star-forming (e.g., Pustilnik et al. 1995, Lindner et al. 1996). Some attempts to address the point of delayed evolution conducted by the study of HI galaxy content (e.g. Pustilnik et al. 2002), or their star formation (Grogin & Geller 2000; Hoyle & Vogeley 2004, Rojas et al. 2004) have arrived to the conclusion that void galaxies are systematically 'less evolved'. However, up to now the data on galaxy metallicities were too scarce to check this statement more directly. We address this issue with our new oxygen abundance data (Pustilnik et al. 2006, in prep.) for a large sample of blue compact galaxies (BCGs).

Method

Our analysis is based on the largest sample of 506 BCGs from the zone of the Hamburg/SAO Survey for ELGs (HSS, Pustilnik et al. 2005), complemented by several similar galaxies from SDSS (Abazajian et al. 2005). We perform the direct comparison of distributions of D_{NN} - distance to the nearest 'luminous' ($L_B > L_*$) galaxy (from UZC sample, Falco et al. 1999) for well selected samples (in the same studied volume with $cz < 7500$ km s^{-1}) of "typical" BCGs (12+log(O/H) > 7.75) and a small subsample of very metal-poor BCGs (12+log(O/H) ≤ 7.75) (see Figure 1). We apply so called '2×2 contingency table test' (e.g., Bol'shev & Smirnov, 1983) that checks the independence of 2 signs of a sample objects (here: low metallicity and low-density environment).

Results

For the constructed BCG subsamples, in which various selection effects (in particular, L-Z relation) and potential interferences (substantial metal loss from the lowest mass galaxies, e.g., Mac Low & Ferrara, 1999) are reduced, we find the significant difference (the confidence level of 0.999) in the respective D_{NN} distributions. Namely, for the brighter BCG subsample ($-17.0 < M_B < -15.5$) there is a relative excess of the metal-poor BCGs in the regions of lower galaxy density, that is for D_{NN} = 4–10 Mpc (9 very metal-poor BCGs of a sample of 10 are in 'void-like' regions, see Figure 2). Besides, we find that at least 10 more very metal-poor BCGs in other regions fall inside voids or near their rims.

Conclusions

1. **This finding is in a qualitative agreement with the CDM model predictions on the underevolved void galaxy population (e.g., Benson et al. 2003).**
2. **It provides new indirect evidences for the important role of interactions in the BCG evolution (already emphasized, e.g., by Pustilnik et al. 2001, and by earlier works cited there).**
3. **It gives a first quantitative estimate of a fraction of underevolved galaxies in voids.**
4. **This also opens a more efficient way to search for unevolved galaxies in the local Universe.**

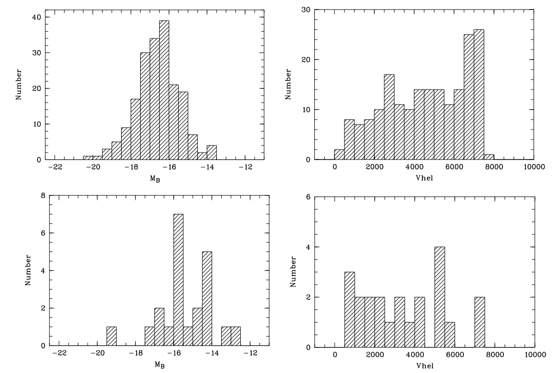

Fig. 1: Upper row: distributions of 192 BCGs in the HSS sample with $V_h \leq 7500$ km s^{-1} and 'normal' O/H on absolute B-magnitude and radial velocity. Bottom row: similar distributions for the sample of 22 'very low O/H' HSS BCGs with $V_h \leq 7500$ km s^{-1}.

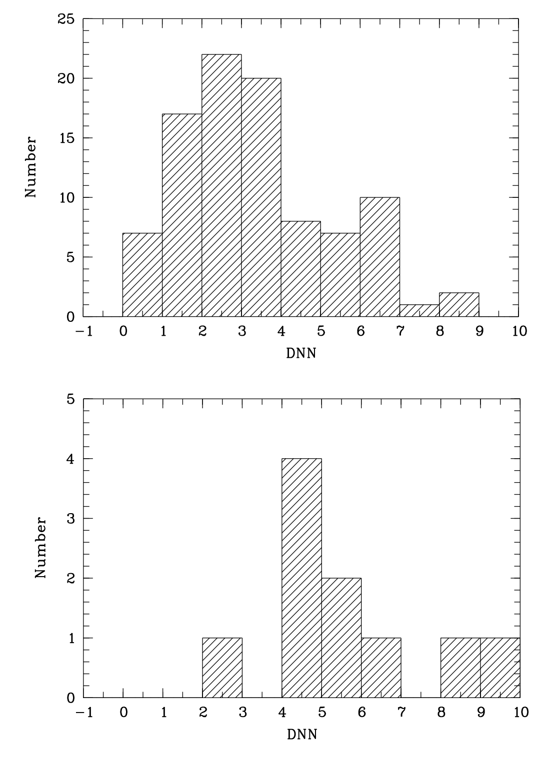

Fig. 2: Distributions of D_{NN} for 94 'normal O/H' BCGs from the HSS sample with $V_h \leq 7500$ km s^{-1} and M_B in the range of −15.5 to −17.0 (top panel), and for the sample of 10 'very low O/H' BCGs with the same M_B limits (bottom panel).

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