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PROPERTIES OF UNUSUAL VOID LSBDS VERSUS COSMOLOGICAL SIMULATIONS PREDICTIONS

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Abstract. We present the study of several unusual galaxies - low-mass, Low Surface Brightness Dwarfs (LSBD) ($M_{\rm bary} \sim 3{\times}10^7$ to $\sim 3 \times 10^9$ $M_\odot$, and $M_{\rm B} \sim -$(12-14.5)) which reside in the nearby Lynx-Cancer void. We confront their properties with the results from recent cosmological simulations, predicting both dynamical properties of low-mass objects and connecting their formation and evolution. In particular, we compare the rotational velocity, the baryonic mass and total dynamical mass with the predictions of Hoeft & Gottloeber (2010), which take into account the suppression of gas accretion onto the low-mass DM halos.

Keywords: galaxies: voids

1 Introduction

Models of galaxy formation (in the context of the popular ΛCDM cosmology) were rather successful for the description of large scale distribution of matter. ΛCDM based N-body cosmological simulations of large volumes show structures and objects quite similar to the observed realm of galaxies. However, this is valid only for large structures and rather massive galaxies. At smaller scales and for low-mass galaxies the situation is not that good. The known problems include the so-called "overabundance problem" and the question of sub-halos around massive galaxies (e.g. Klypin et al. (1999) and Tikhonov & Klypin (2009)), and the low-mass end of galaxy mass/luminosity function in the field/voids. The number of visible objects with $M_{\rm B} < -14$, which probably form a complete sample in the nearby Lynx-Cancer void (see Pulstilnik & Tepliakova (2011)) is several times smaller than the number of DM halos expected from the high-resolution ΛCMD simulations by Gottlöber et al. (2003). It is not clear whether this indicates the real limits of the ΛCDM cosmology and requires the extension of the paradigm, or that the failures of ΛCDM simulations are caused by a still too low spatial resolution and a poor understanding of the underlying physics of galaxies and star formation. However, improvement of our knowledge of the low-mass galaxies, including a more precise determination of their dynamics and evolutionary paths should be crucial for current and future comparison with various model predictions. Since dwarf galaxies are more sensitive to external tidal perturbations which change their dynamics and SF, one should try to avoid interacting objects as much as possible in order to form a good observational dataset. It is natural to assume that the mutual effects of galaxy encounters are minimal in the most rarefied regions - i.e. large voids outlined by filaments and walls, in which the matter density can be as low as 0.1 of the mean density. The detailed study of the least massive void galaxies can give us a valuable material to confront their properties and spatial distribution with the results of state-of-art cosmological simulations.

2 First results

In the context of the study of the Lynx-Cancer void deep sample of ~ 80 galaxies from Pulstilnik & Tepliakova (2011) we have identified a half-dozen faint LSB dwarfs with extremely low metallicities, 12+log(O/H) $\lesssim 7.30$

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(Pulstilnik et al. (2011)). These galaxies are gas-dominated ($f_{gas} \gtrsim 0.95$), and the ages of the oldest visible stellar populations are in the range of $\sim$1 to $\sim$3 Gyr (for part of them). They are probably the best galaxies in order to compare their dynamics and baryonic content with the predictions of the modern models. In the figure 1 we present 4 dwarf galaxies from the Lynx-Cancer void sample (J0723+3621, J0737+4724, J0852+1350, J0926+3343) with the range of $M_{\rm bary}$= (0.4-4)$\times 10^8$ $M_{\odot}$ and with $V_{\rm rot}$ = 24–50 km s^{-1}. The predictions of $M_{\rm bary}/{\rm M}_{\rm tot}$ for the void dwarfs have been published by Hoeft & Gottlöber (2010) in the context of ΛCDM simulations taking into account the gas heating by the UV background. Model and observational ratios match together if one takes into account the expected large ratio between the linear scales of DM mass estimates in models ($R_{\rm virial}$) and observations (R(HI)). Surprisingly, for the discussed LSBDs this ratio varies between $\sim$1 for $V_{\rm rot} \sim$ 50 km s^{-1} to $\sim$5 for $V_{\rm rot} \sim$ 24–30 km s^{-1}: this might indicate that a more careful analysis of the modeling basic assumptions is needed.

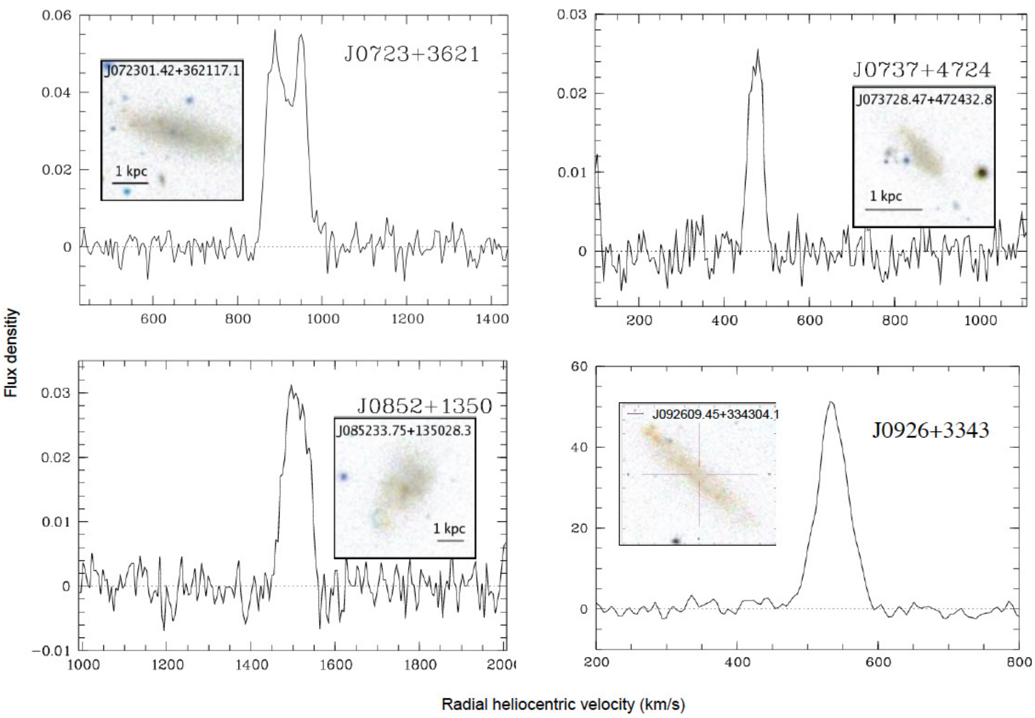

Fig. 1. HI spectra and SDSS images of 4 dwarf galaxies from the Lynx-Cancer void sample. Flux densities are given in Jy (except for J0926+3343, which has a mJy scale). 21-cm spectra have been obtained with the Nançay Radio Telescope and the standard spectral correlator. Radial velocities and abundances have been obtained with the SAO 6m telescope and/or with the SDSS database.

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