

Serendipitous discovery of a pair of faint dwarf galaxies

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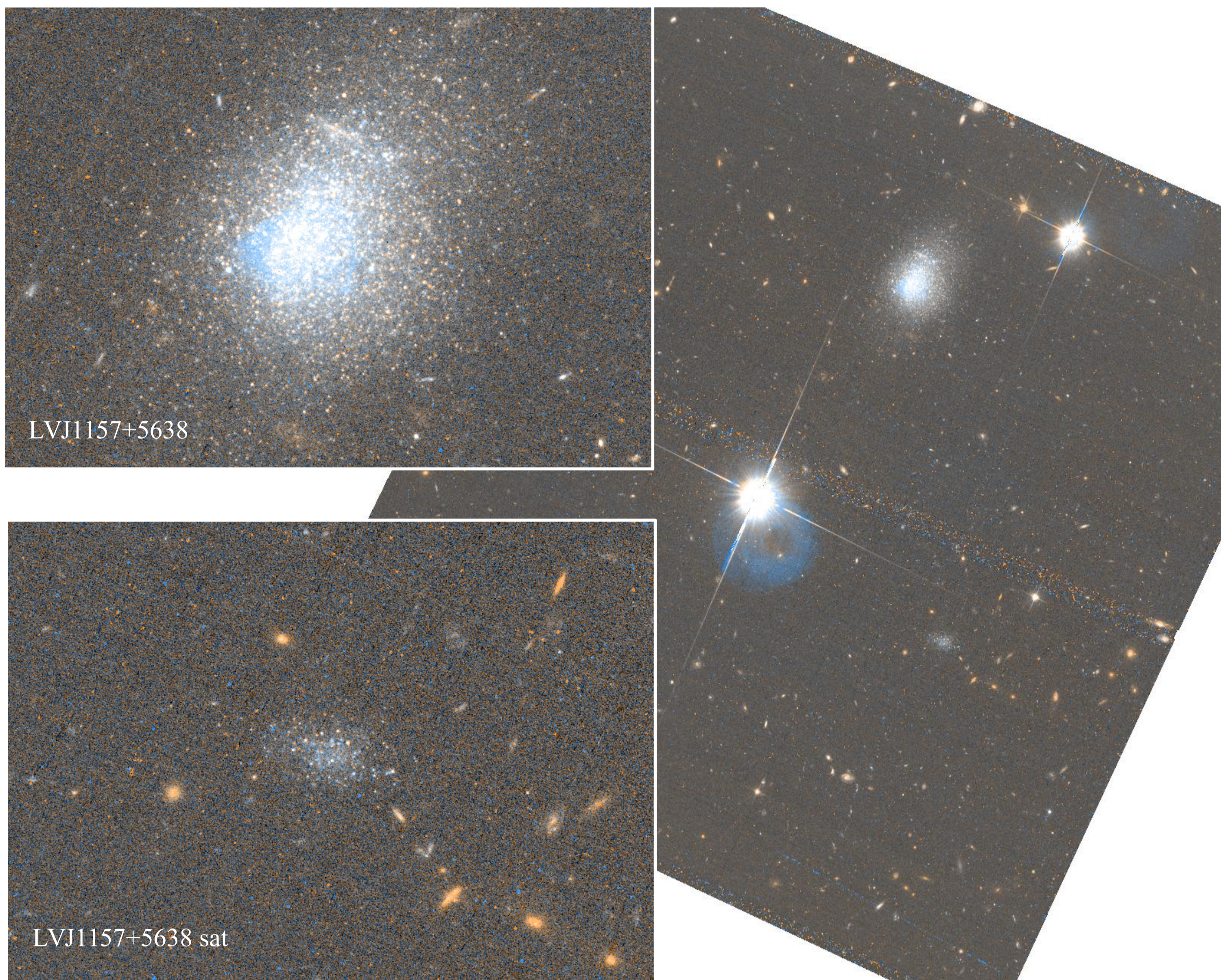


A lubok (Russian: лубок, лубочная картинка) is a Russian popular print, characterized by simple graphics and narratives derived from literature, religious stories and popular tales.



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In the framework of the study of the distribution and peculiar motion of galaxies in the Local Volume with Hubble Space Telescope we discovered a physical pair of dwarf galaxies with the absolute magnitudes of $M_V = -13.3$ and -9.4 mag. We determined the distance to this pair of 9.2 Mpc using the tip of the red giant branch. The projected separation between the galaxies in pair is only 3.9 kpc. The existence of such systems of dwarfs is not unusual. On a scale of 3 Mpc most dwarfs are associated with either a luminous group or associations of dwarf galaxies. The groups of dwarfs where both components have the luminosity lower than the Small Magellanic Cloud form a significant population of all groups on the scale of 40 Mpc. The newly discovered system of dwarfs is one of the faintest known groups of galaxies.



	LV J1157+5638	LV J1157+5638 sat
Position (J2000) ^a	11 ^h 57 ^m 53 ^s .9 +56°38'17"	11 ^h 57 ^m 53 ^s .0 +56°36'49"
$E(B - V)^b$, mag	0.017	0.017
V_T , mag ^c	16.61 ± 0.04	20.43 ± 0.06
I_T , mag	16.05 ± 0.04	19.75 ± 0.06
M_V , mag	-13.26 ± 0.10	-9.38 ± 0.13
M_I , mag	-13.80 ± 0.10	-10.04 ± 0.13
Central surface brightness in V , mag arcsec ⁻²	21.15 ± 0.04	23.16 ± 0.06
Central surface brightness in I , mag arcsec ⁻²	21.02 ± 0.02	22.71 ± 0.06
Exponential scale length in V , arcsec	3.23 ± 0.02	1.39 ± 0.03
Exponential scale length in I , arcsec	3.96 ± 0.02	1.45 ± 0.04
Holmberg diameter in V , $a_{26.5}$, arcsec / kpc	30.0/1.36	8.4/0.37
Holmberg diameter in I , $a_{26.5}$, arcsec / kpc	39.8/1.79	10.2/0.44
Heliocentric radial velocity ^d , km s ⁻¹	416.3 ± 1.4	-
Radial velocity relative to the Local Group ^e , km s ⁻¹	514	-
Distance modulus, mag	29.82 ± 0.09	29.76 ± 0.11
Distance, Mpc	9.22 ± 0.38	8.95 ± 0.42
Mean metallicity of RGB, [Fe/H], dex ^f	-2.30 ± 0.07	-2.08 ± 0.10
$F(H\alpha)$, erg/cm ² sec ^g	9.33×10^{-14}	$< 0.4 \times 10^{-14}$
$\log(\text{SFR})(H\alpha)$, $M_\odot \text{ yr}^{-1}$	-2.10	<-3.50
$m(\text{FUV})$, mag ^h	18.49	22.71
$\log(\text{SFR})(\text{FUV})$, $M_\odot \text{ yr}^{-1}$	-2.63	-4.35

Notes. ^aThe measurements were made from the HST/ACS images.

^bFrom Schlafly & Finkbeiner (2011).

^cThe total magnitudes and central surface brightness are not corrected for Galactic extinction, whereas absolute magnitudes are corrected for the Galactic extinction.

^dfrom SDSS DR12.

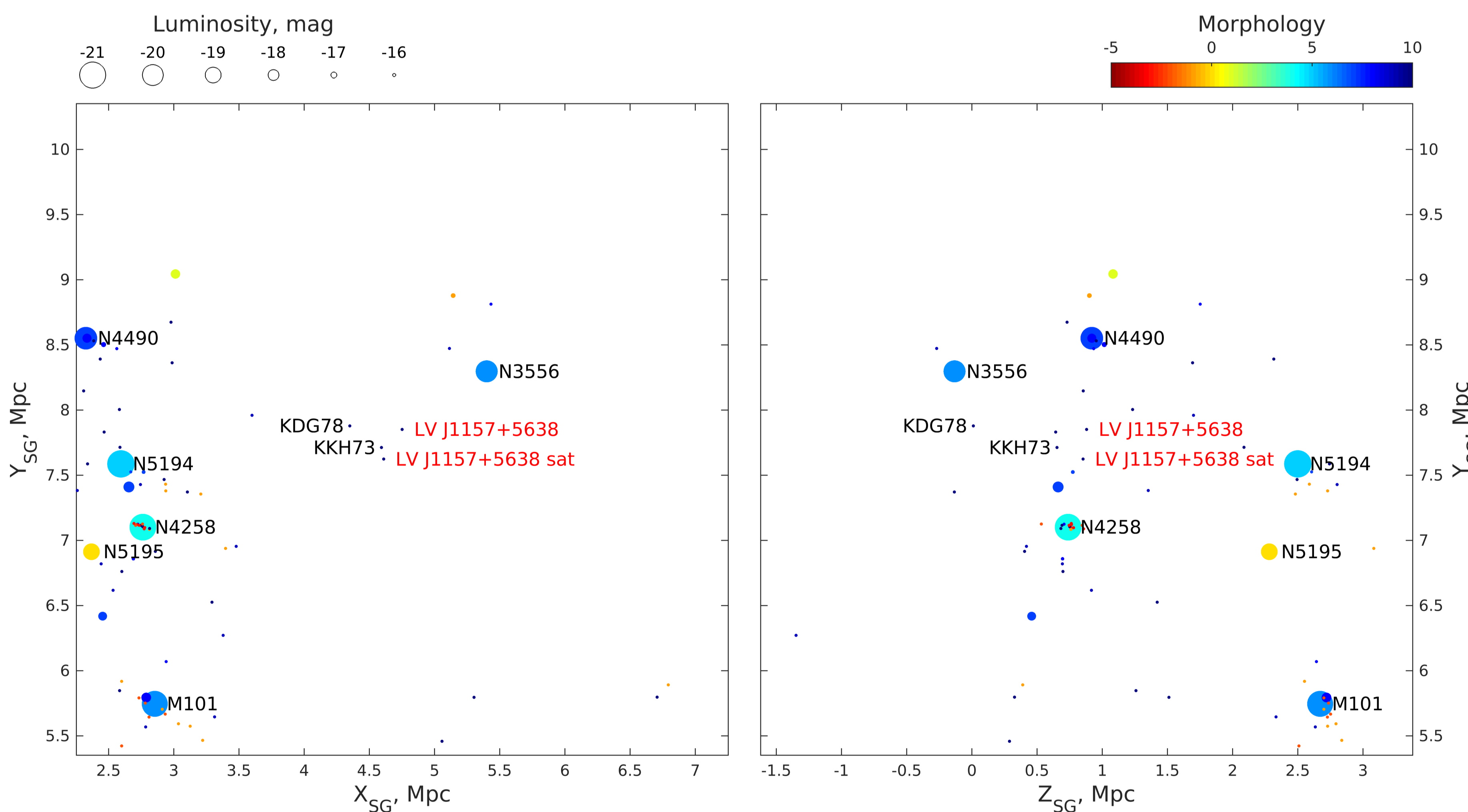
^efrom the Catalog & Atlas of the LV galaxies data base: <http://www.sao.ru/lv/gvdb/>

^fThe small [Fe/H] uncertainties are mostly reflect the formal errors of the estimate defined by expression given in the Section 4.

^gUsing data from Karachentsev, Kaisin & Kaisina (2015) and our distances.

^hThese GALEX magnitudes were obtained from the Mikulski Archive for Space Telescopes (MAST) (GALEX Public Release GR6/GR7). We estimate the respective SFR with the recipe given in the LV galaxies data base for the similar data.

HST/ACS combined distortion-corrected image of the LVJ1157+5638 field in the F606W/F814W filters.



A panorama of the LVJ1157+5638 neighborhood in the supergalactic coordinates. The figure shows the projection of galaxies in a cube of ± 2.5 Mpc size. The left-hand panel is a "top view" projection on the supergalactic plane XY, while the right-hand panel is the "edge-on view" of the distribution of galaxies. The color of a dot represents the morphology of the galaxy according to the color bar. The size of a galaxy corresponds to its luminosity as shown in the legend panel.

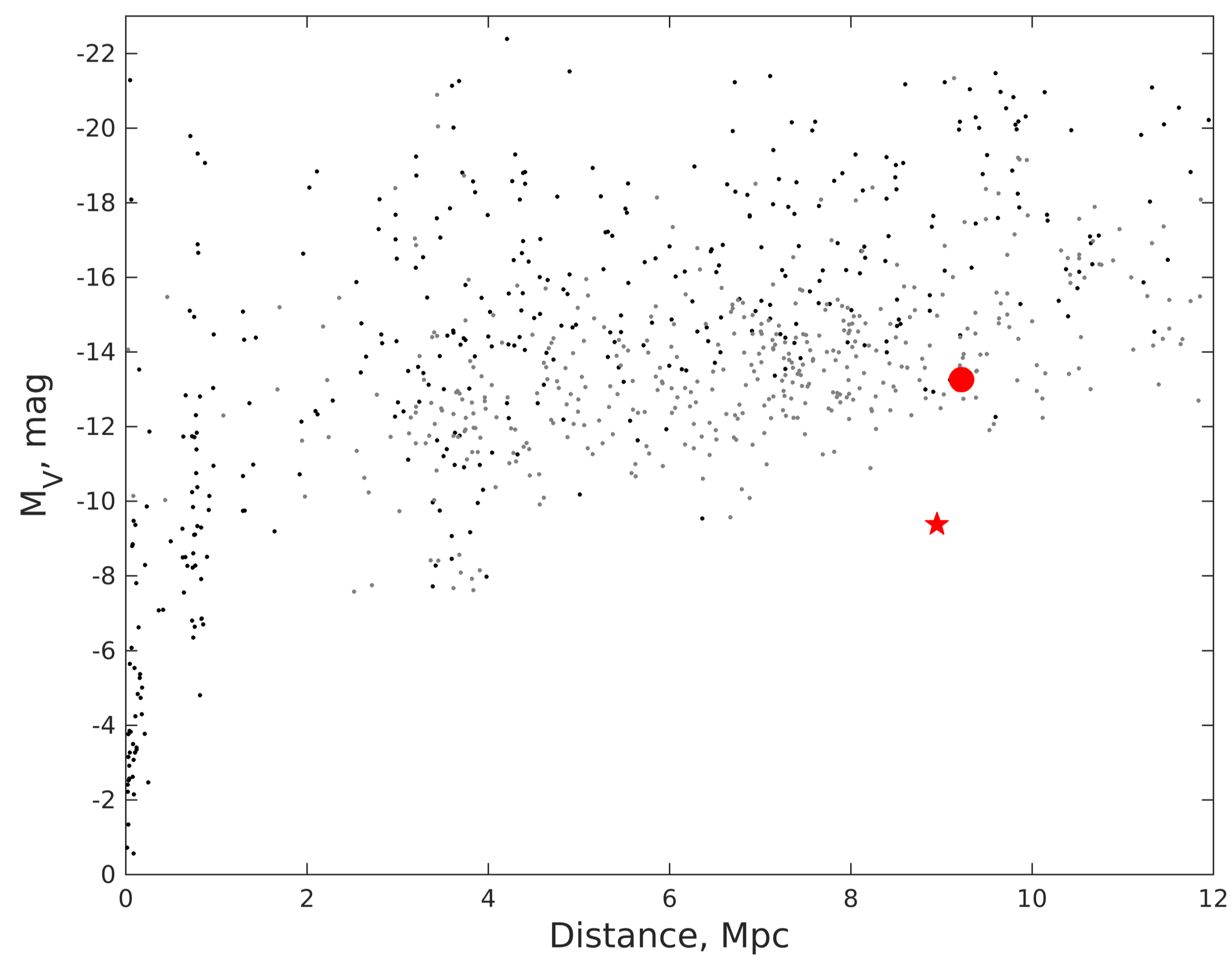
We discover a new faint dwarf irregular galaxy, detected in the HST/ACS images. The galaxy is resolved into individual stars, including the RGB, which allowed us to measure the TRGB distance. According to our analysis this dwarf is a satellite of dwarf irregular LVJ1157+5638. This pair is situated far away from any giant galaxies and their satellite families. The closest neighbor, dwarf irregular galaxy KKH 73, is situated at the projected distance of 83 arcmin (220 kpc) from LVJ1157+5638. The second nearest galaxy, dwarf irregular KDG 78, is located at the projected distance of 352 arcmin (940 kpc) from LVJ1157+5638. Both galaxies KKH 73 and KDG78, do not have redshift independent distance estimations. Their heliocentric radial velocities $V_h(\text{KKH } 73) = 596 \pm 6 \text{ km s}^{-1}$ and $V_h(\text{KDG } 78) = 574.8 \pm 1.7 \text{ km s}^{-1}$, exceed the radial velocity of $V_h(\text{LV } 1157+5638) = 416.3 \pm 1.4$ over 150 km s^{-1} . It is highly unlikely that they form a physically bounded system.

While the family of dwarfs in the Local Group is relatively well studied, a number of known faint dwarf galaxies is rapidly decreases with increasing distance. It is obvious, that LVJ1157+5638 sat is extremely faint for its distance. The figure illustrates that most of faint satellites are still unknown at the distance of 5–10 Mpc.

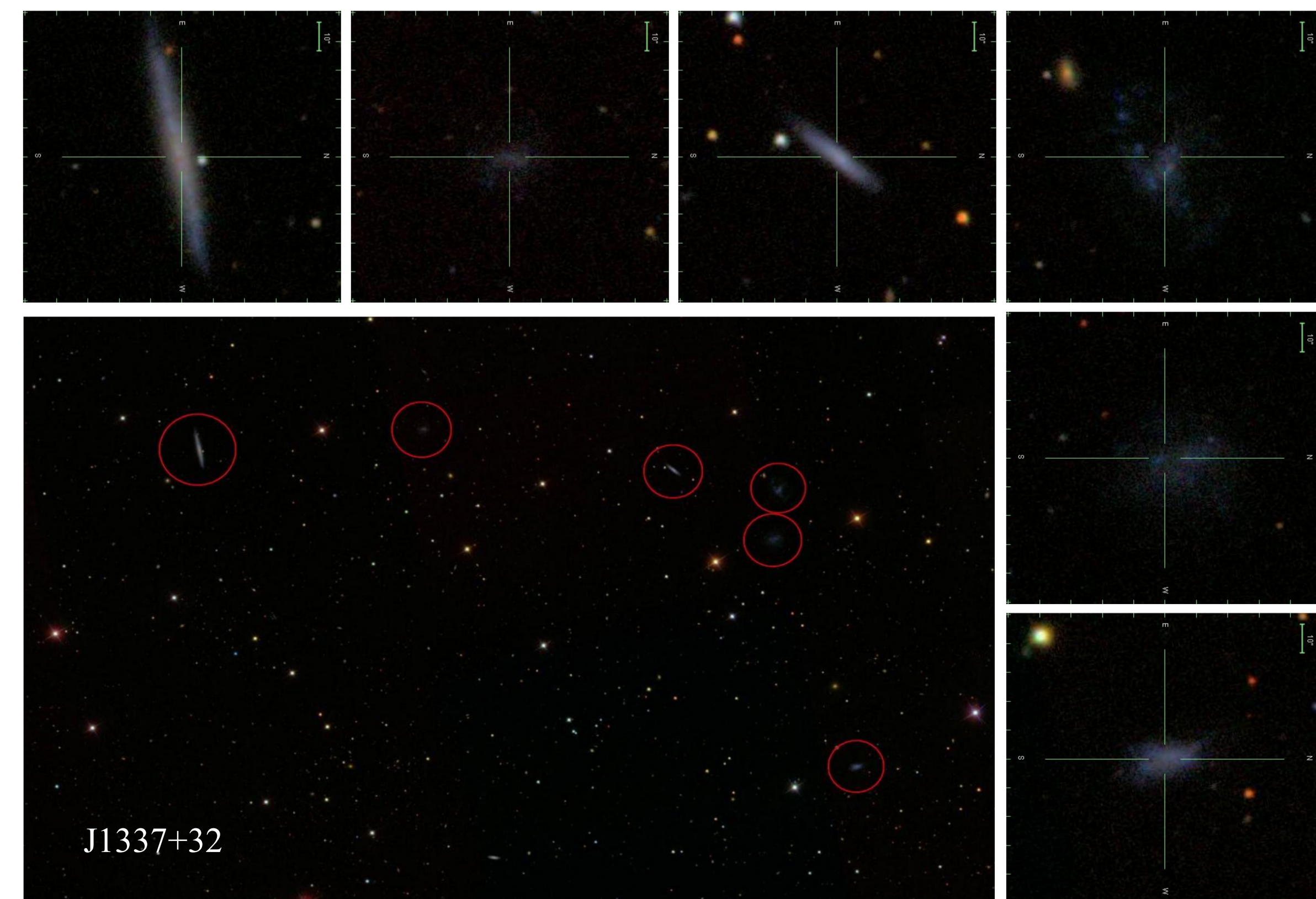
According to Makarov & Uklein (2012) describes big population of groups consisting of dwarfs only. These groups form a continuous sequence in the distribution of luminosities and masses with associations of dwarfs discovered by Tully et al. (2006) in the 3D distribution of nearby galaxies. The newly discovered pair of dwarf galaxies LVJ1157+5638 represents an example of a group of extremely low luminosity. This extends the sequence of dwarf galaxy groups to the faint and ultrafaint luminosities.

According to hydrodynamic zoom-in simulations of isolated dark matter haloes (Wheeler et al. 2015) every halo of dark matter is filled with subhalos, many of which form stars. The simulated dwarf galaxies with $M_* \approx 10^6 M_\odot$ host 1–2 satellites with $M_* = 2\text{--}200 \times 10^3 M_\odot$. Thus, dwarf galaxies throughout the universe should host tiny satellite galaxies of their own. Dooley et al. (2017) also predict 1–6 (2–12) satellites with $M_* > 10^5 M_\odot$ ($M_* > 10^4 M_\odot$) within the virial volume of LMC-sized galaxies. The finding and observing of the faint satellites of dwarf galaxies is a crucial test for the modern Λ CDM theory.

This study is supported by the Russian Science Foundation grant 14-12-00965.



A relation between linear distance and total absolute V-band magnitude for the Local Volume galaxies. The data are taken from the HyperLeda data base. Black dots are represent original measurements, and gray dots are the magnitudes originally measured in B and translated to the V magnitudes according to the mean colours from Sharina et al. (2013). LVJ1157+5638 is shown with red circle and LVJ1157+5638 sat with red star.



An example of the most populated group of dwarf galaxies (Makarov & Uklein, 2012)