Peekaboo: the extremely metal poor dwarf galaxy HIPASS J1131–31

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ABSTRACT

The dwarf irregular galaxy HIPASS J1131–31 was discovered as a source of HI emission at low redshift in such close proximity of a bright star that we call it Peekaboo. The galaxy resolves into stars in images with Hubble Space Telescope, leading to a distance estimate of 6.8 ± 0.7 Mpc. Spectral optical observations with the Southern African Large Telescope reveal HIPASS J1131–31 to be one of the most extremely metal-poor galaxies known with the gas-phase oxygen abundance 12+log(O/H) = 6.99±0.16 dex via the direct [OIII] 4363 line method and 6.87±0.07 dex from the two strong line empirical methods. The red giant branch of the system is tenuous compared with the prominence of the features of young populations in the color-magnitude diagram, inviting speculation that star formation in the galaxy only began in the last few Gyr.

Key words: galaxies: dwarf– galaxies: individual (HIPASS J1131–31) – galaxies: irregular –

Figure 1. Two-colour HST image of the dwarf galaxy HIPASS J1131–31, consisting of ACS F606W (blue) and F814W (red). The image dimensions are ∼ 70″ × 45″, and North is up. The foreground star, TYC 7215-199-1 (10.4 mag), is located ∼15 arcsec to the North. Part of its diffraction pattern is included in the displayed image.

Peekaboo
716км/с
Открыта в HIPASS

HST + ATCA + SALT

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Мало красных старых звезд
D= 6.8 ± 0.7 Mpc

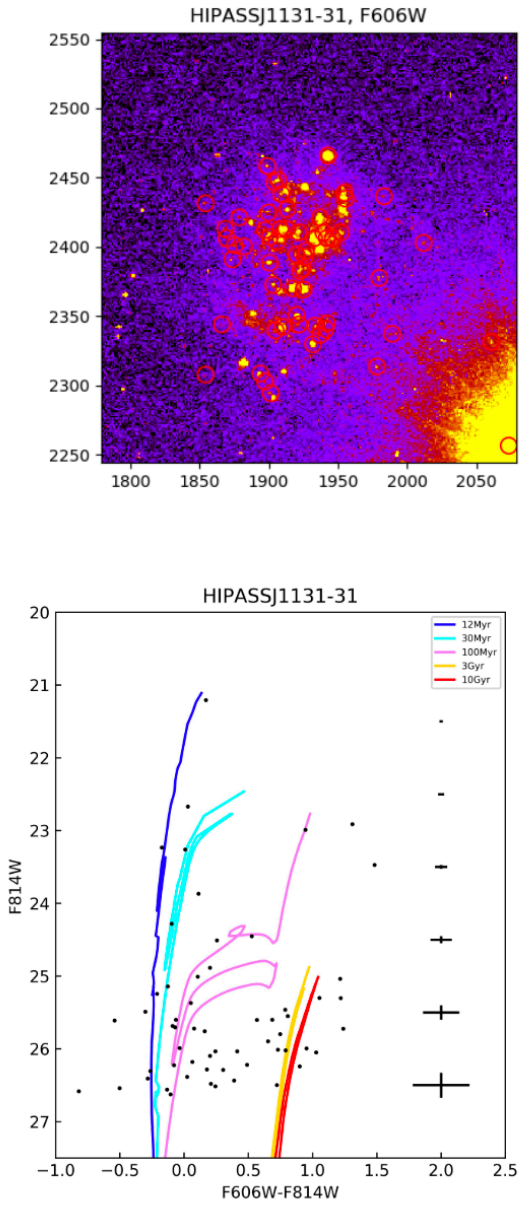


Figure 2. Top: HST/ACS F606W image of the Peekaboo galaxy with the indicated pixel coordinates. North is in the direction toward the bottom-right corner. Stars detected within the galaxy are marked with open red circles. — **Bottom:** HST/ACS derived colour magnitude diagram of the Peekaboo galaxy. We overlay PARSEC stellar isochrones (Bressan et al. 2012; Marigo et al. 2013) assuming a metallicity of $Z = 0.0002$ and a distance of 7.0 Mpc.

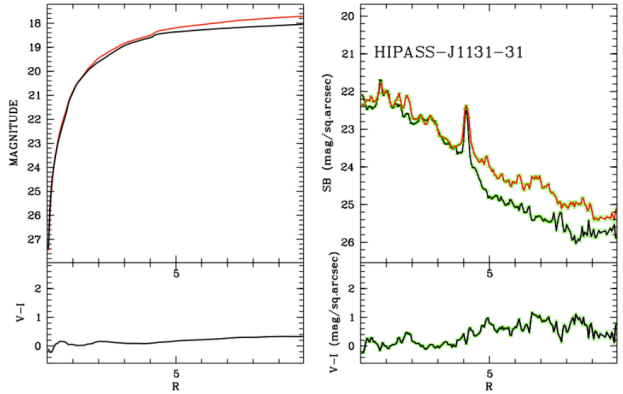
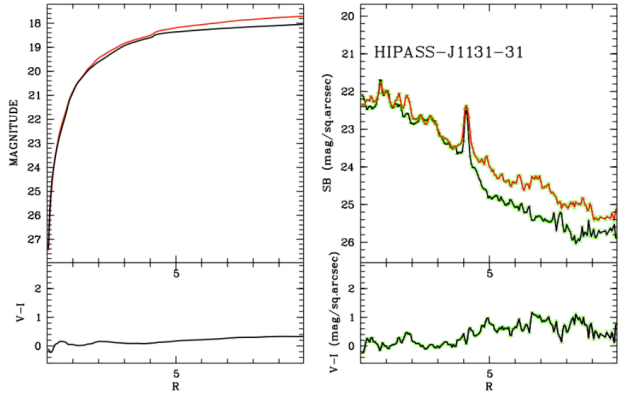


Figure 3. Surface brightness photometry of the galaxy HIPASS J1131–31 as obtained from the HST ACS V- and I-band images. — **Left:** The integral magnitude of the galaxy in the I and V filters and the integral colour index as a function of the circular radius R in arcseconds. **Right:** The measured profile of the galaxy brightness in the I and V bands and variations of the colour index ($V - I$) with dependence on R in arcseconds.



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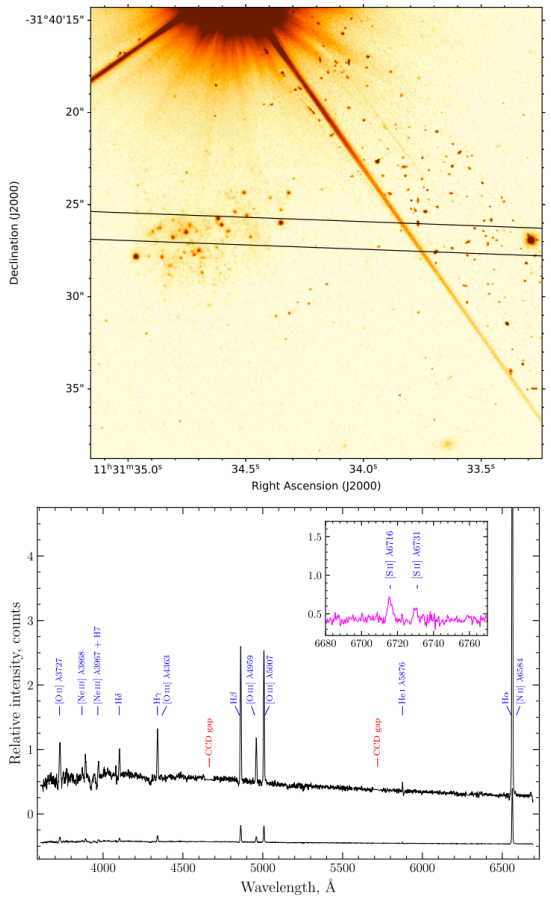


Figure 6. Top: Long-slit position for the spectral observations of HIPASS J1131–31. The slit width is 1.″5. The relatively bright star that is located in the slit was used as the reference star to be sure that specific part of the galaxy will be observed. **Bottom:** SALT optical spectrum of HIPASS J1131–31 with the most prominent lines indicated. The spectrum at the bottom is scaled by 1/8 and shifted to show the relative intensities of the strong lines.

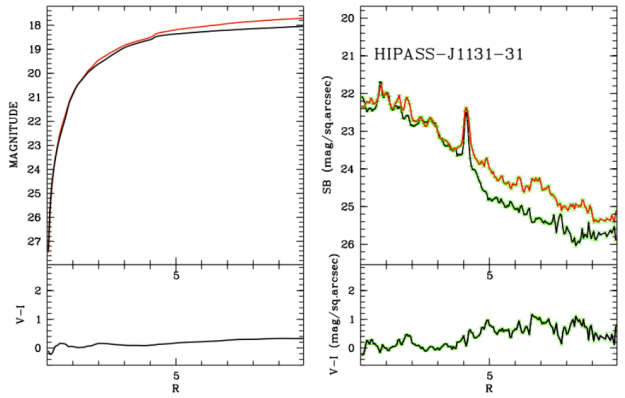
Table 1. Peekaboo galaxy line intensities

λ_0(Å) Ion	F(λ)/F(Hβ)	I(λ)/I(Hβ)
3727 [O II]	0.329±0.042	0.352±0.049
3868 [Ne III]	0.050±0.019	0.053±0.022
4101 Hδ	0.175±0.018	0.269±0.034
4340 Hγ	0.398±0.022	0.473±0.031
4363 [O III]	0.025±0.010	0.024±0.011
4861 Hβ	1.000±0.017	1.000±0.021
4959 [O III]	0.325±0.017	0.299±0.017
5007 [O III]	0.990±0.034	0.906±0.033
6563 Hα	3.353±0.087	2.709±0.082
6584 [N II]	0.029±0.005	0.023±0.005
6716 [S II]	0.043±0.002	0.034±0.002
6731 [S II]	0.021±0.001	0.017±0.001
C(Hβ) dex	0.20±0.03	
$E(B-V)$ mag	0.14±0.02	
EW(abs) Å	2.25±0.33	
EW(Hβ) Å	30± 2	
6716/6731 [S II]	2.00±0.25	
N_e(SII)(cm^{-3}	10±10	
T_e(OIII)$_{4363}$(K)	17,555±4120	
T_e(OIII)$_{P21}$(K)	23,000±1760	
12+log(O/H)$_{4363}$ dex	6.99±0.16	
12+log(O/H)$_{P21}$ dex	6.80±0.05	
12+log(O/H)$_{ITG21}$ dex	6.93±0.02	

-> Относится к eXtremely Metal-Poor галактикам
Отклоняется на 0.5dex от зависимости «светимость - сметалличность»

Одна из самых низкометалличных, при этом самая близкая.

При текущем темпе 30 запасов газа хватит на 18млрд лет!
При этом могла нарастить звездную массу за 1.1млрд лет
Хороший кандидат в молодые галактики.



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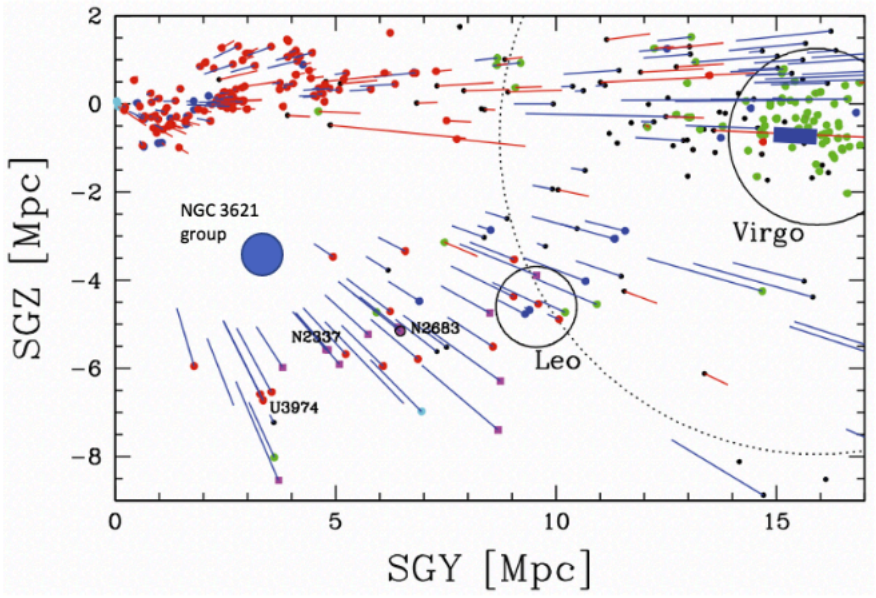
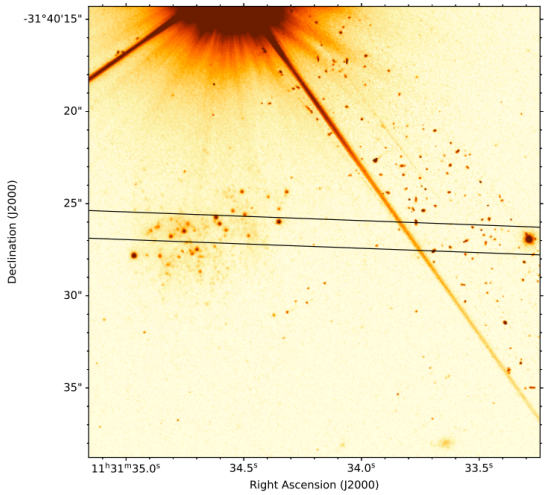
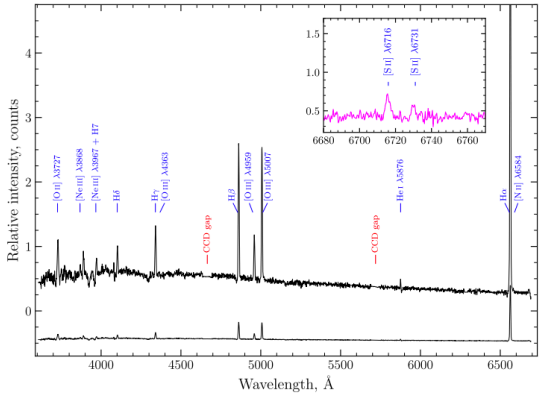


Входит в бедную группу, но относительно изолирована.
Находится в окружении низкой плотности.





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Хороший кандидат в молодые галактики.

Searches for Extremely Metal Poor Galaxies using ALFALFA-selected Dwarf Galaxies*

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[2] *Minnesota Institute for Astrophysics, University of Minnesota, 116 Church Street, Minneapolis, MN 55455, USA*
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[5] *Space Telescope Science Institute, 3700 San Martin Dr., Baltimore, MD 21218, USA*

ABSTRACT

We present a study of nearby dwarf galaxies selected from the ALFALFA blind H I survey. A primary goal of the project was to utilize a non-standard selection method with the hope of detecting previously unrecognized extremely metal-poor (XMP) galaxies. The study was motivated by the recent discovery of two XMP galaxies – Leo P and Leoncino – which were both originally found via the ALFALFA survey. We have obtained narrowband Hα images for 42 dwarf systems, many of which are located in the local void in front of the Pisces-Perseus Supercluster. Spectra for eleven of the best candidates resulted in the determination of metal abundances for ten of the systems. None were found to be extremely metal poor, although one system (AGC 123350) was found to have an oxygen abundance of log(O/H)+12 = 7.46, or ∼6% solar. One of the galaxies in our sample exhibits a high oxygen abundance for its luminosity, suggesting the possibility that it may have a tidal origin.

Слепой HI обзор ALFALFA:
Массы HI менее 10^8 (вплоть до 10^6) в близкой Вселенной
Вошло 31500 внегалактических источников HI
(в основном S/N> 6.5σ)

Проекты SHIELD (Survey for HI in Extremely Low-mass Dwarfs)
и UCHVC (Ultra-Compact High Velocity Clouds)
-> открыты 2 новых XMP галактики (Leo P, Leoncino)

Решили поискать еще, среди 4σ < S/N < 6.5σ
+ ограничения по скоростям и координатам
-> 78 кандидатов
Часть попадает в Местный войд.

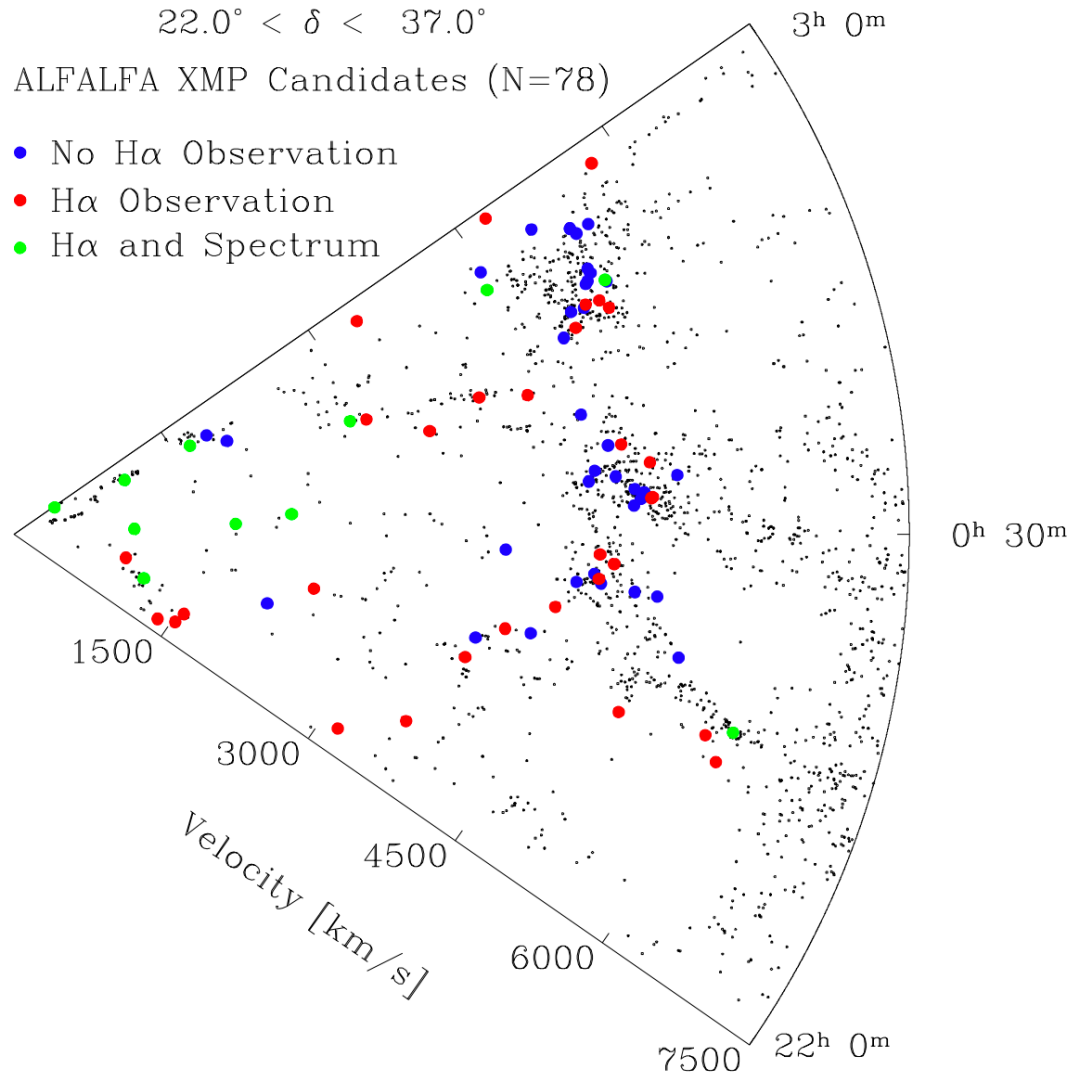


Figure 1. Cone diagram showing the spatial distribution of galaxies in our survey region. The small black dots represent galaxies from various redshift surveys, including the ALFALFA survey (Haynes et al. 2018), collected from the literature and included in the Arecibo Galaxy Catalog (AGC) which is maintained by MPH. These galaxies are used to define the large-scale structure in this region of the nearby universe. The current sample of XMP candidates selected from among the ALFALFA survey low SNR subsample are shown as colored circles. Blue circles represent candidates that were not observed as part of our narrowband imaging project, red circles were galaxies for which Hα NB images were obtained, while green circles were observed in Hα as well as spectroscopically.

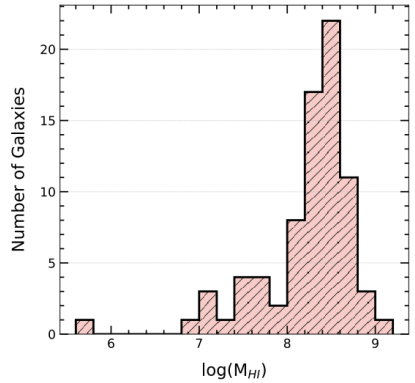


Figure 2. A histogram of the log of M_{HI} for the ALFALFA selected galaxies. The median and average values of $\log(M_{HI})$ are 8.36 and 8.24, respectively.

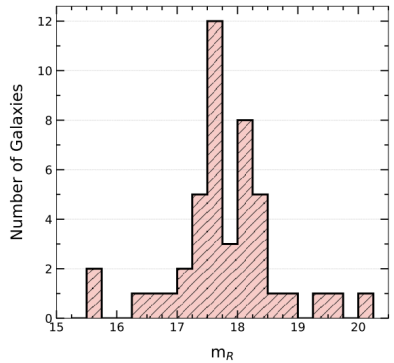


Figure 3. A histogram of the apparent magnitudes for the observed galaxies. The median and average values of m_R are 17.71 and 17.79, respectively.

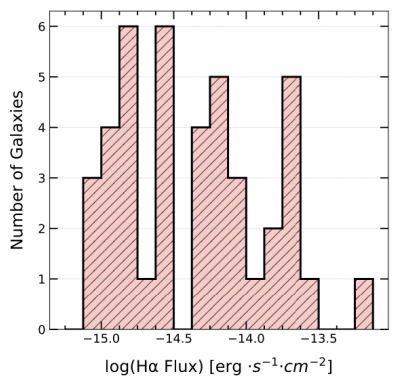
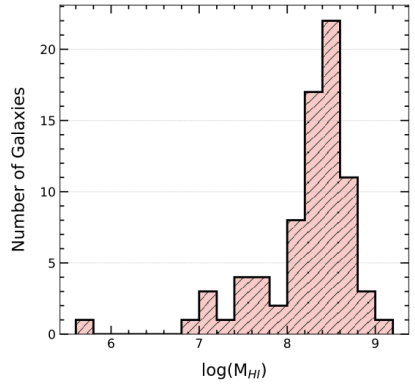


Figure 4. A histogram of the log of the Hα flux for the observed galaxies. The median and average values of the Hα flux for the XMP galaxies are 0.285 and 0.778 x10^{-14} ergs s^{-1} cm^{-2}, respectively. Three observed galaxies, AGC 322064, AGC 123101, and AGC 334595, were not included due to non-detections in Hα.



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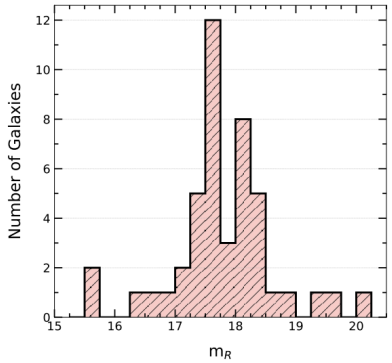

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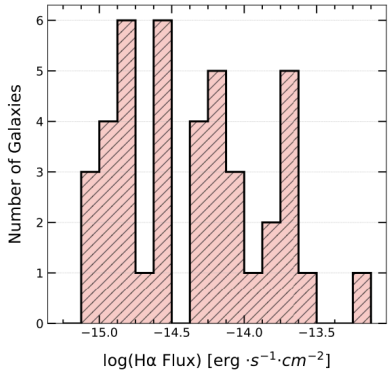

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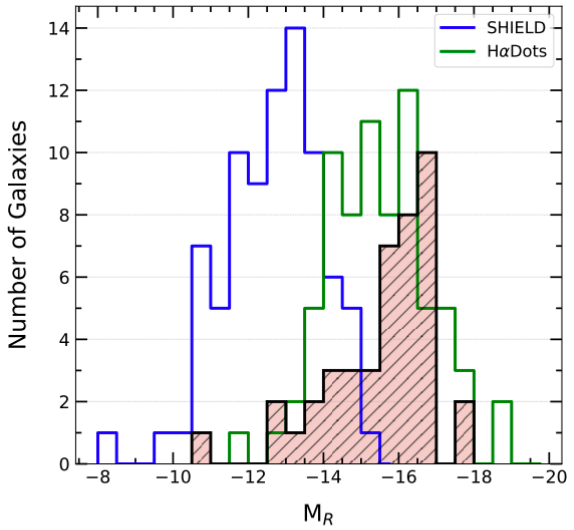


Figure 5. A histogram of the absolute magnitudes for the observed galaxies (solid) and two comparison samples: Hα Dots (green) and SHIELD (blue). The median and average values of the M_R values are -15.99 and -15.56, respectively.

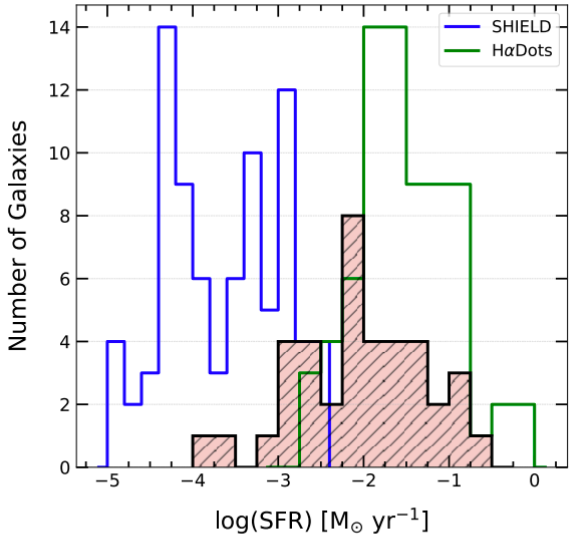
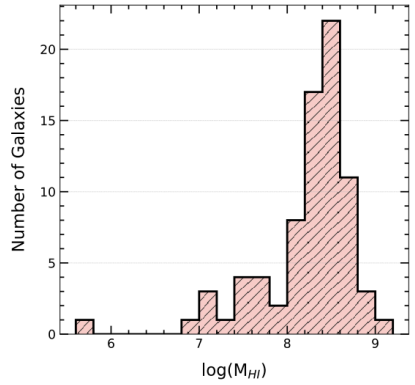


Figure 6. A histogram of the SFRs for the observed galaxies (solid) and two comparison samples: Hα Dots (green) and SHIELD (blue). The median and average values for the log of the SFRs are -2.01 and -1.89 $M_\odot$ yr^{-1}, respectively.



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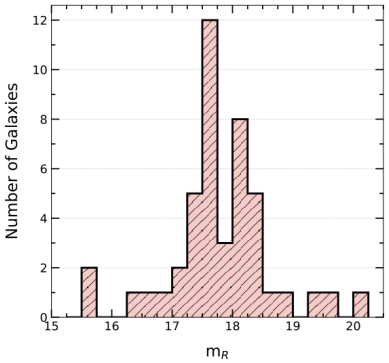

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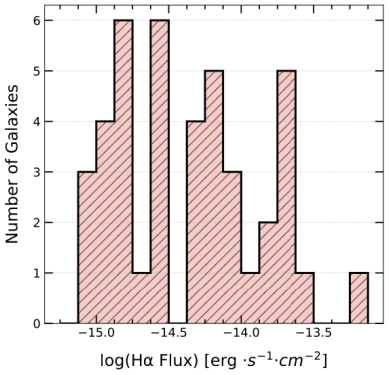

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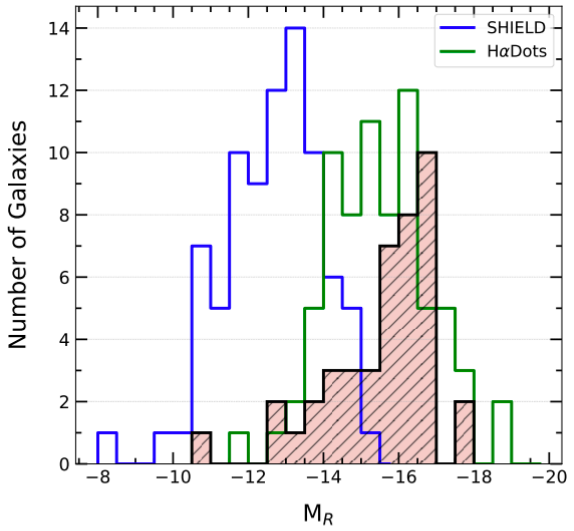

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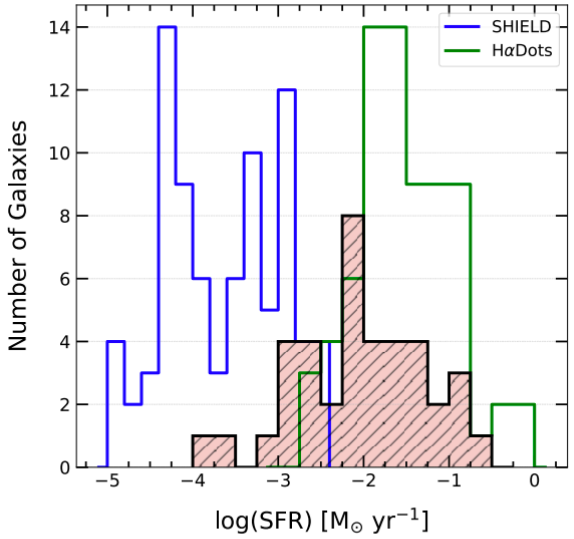

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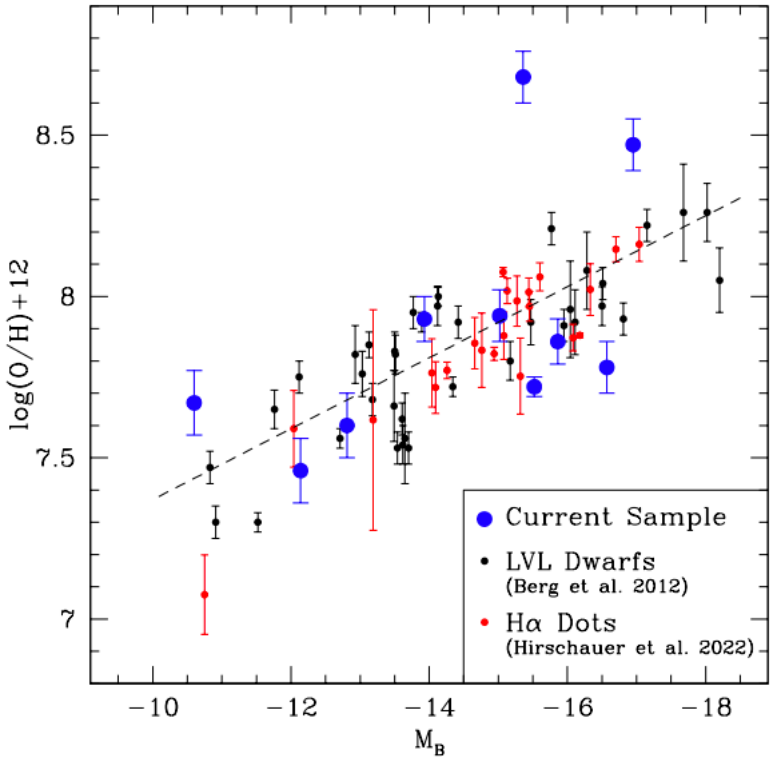

Figure 11. Luminosity-metallicity relation (LZR) plot for the current sample. The ALFALFA dwarfs are plotted as blue circles. Also shown, for comparison, are the Berg et al. (2012) LVL sample (black dots) and the Hirschauer et al. (2022) Hα Dots sample (red dots). The dashed line is the formal linear fit to the LVL sample, also from Berg et al. (2012). The ALFALFA dwarfs are seen to follow the same LZR defined by the other dwarf galaxy samples. The most extreme outlier from the current sample, AGC 122939, is discussed in the text.

Не удалось найти ни одной XMP галактики ☹
Самая низкая металличность log(O/H)+12 = 7.46, ~6% солнечной
Поиск таких объектов – сложный и трудозатратный процесс