Star Formation in Nearby Isolated Galaxies

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We use the FUV fluxes measured with the GALEX to study the star formation properties of galaxies collected in the “Local Orphan Galaxies” catalog (LOG). Among 517 LOG galaxies having radial velocities $V_{LG} < 3500$ km/s and Galactic latitudes $|b| > 15^\circ$, 428 objects have been detected in FUV. We briefly discuss some scaling relations between the specific star formation rate (SSFR) and stellar mass, H I-mass, morphology, and surface brightness of galaxies situated in extremely low density regions of the Local Supercluster. Our sample is populated with predominantly late-type, gas-rich objects with the median morphological type of Sdm. Only 5% of LOG galaxies are classified as early types: E, S0, S0/a, however, they systematically differ from normal E and S0 galaxies by lower luminosity and presence of gas and dust. We find that almost all galaxies in our sample have their SSFR below 0.4 [Gyr$^{-1}$]. This limit is also true even for a sample of 260 active star-burst Markarian galaxies situated in the same volume. The existence of such a quasi-Eddington limit for galaxies seems to be a key factor which characterizes the transformation of gas into stars at the current epoch.

1. INTRODUCTION

According to current concepts, the transformation of gas into stars in galaxies is controlled by the internal processes and depends on the mass and morphological type of the galaxy. Furthermore, the global star formation rate is influenced by external factors: bursts of star formation in close encounters or mergers of galaxies, sweeping out of gas from low-mass companions while they pass through the dense regions of the halo of the giant (host) galaxy. Another hidden mechanism of evolution can be the accretion by the galaxy of the warm intergalactic medium which presumably holds about 90% of all baryons in the Universe [1]. The contribution of the latter factor in the history of star formation remains quite unclear.

To make clearer the role of internal processes of gas conversion into stars, we have to explore them in the galaxies, isolated from their neighbors to the maximum extent. The appearance of the mass survey of ultraviolet radiation of galaxies made at the GALEX space telescope [2, 3], opens the potential for a detailed study of star formation rates in nearby isolated galaxies for which there exist sufficiently detailed data on their structure and abundance of gas. Below we consider the features of star formation in a representative sample of the most isolated galaxies of the Local Supercluster, based on the data on their fluxes in the far ultraviolet (FUV) from the GALEX satellite. To our knowledge, this work is the first systematic attempt to analyze the rates of star formation in the homogeneous sample of single galaxies in the present epoch ($z < 0.01$).

2. SAMPLE OF ISOLATED NEARBY GALAXIES

Using the HyperLEDA1 and NED2 databases, Karachentsev, Makarov and Karachentseva compiled a summary of approximately 11000 galaxies of the Local Universe with radial velocities relative to the centroid of the Local Group $V_{LG} < 3500$ km/s at the galactic latitudes $|b| > 15^\circ$. Preparing this sample (11K) we took into

1 http://leda.univ-lyon1.fr
2 http://nedwww.ipac.caltech.edu
account the new data on radial velocities of galaxies obtained in the optical and H I sky surveys: SDSS, 6dF, HIPASS, ALFALFA. Furthermore, we have refined or determined for the first time the morphological types, apparent magnitudes and other parameters for many galaxies of the 11K-sample.

The application of the new galaxy clustering criterium to the 11K-sample has led to the creation of the catalogs of pairs, triplets and groups of galaxies in the Local Universe [4–6]. For the dwarf galaxies with \( V_m < 39 \) km/s and gas-poor E, S0 galaxies, internal extinction was considered negligible.

Supplementing the LOG catalog with the FUV flux values, we have filled it with new data on the HI fluxes of galaxies from the EDD\(^3\) database, as well as checked and refined the data on morphological types and apparent magnitudes of galaxies. Three galaxies have been removed from the LOG catalog: LOG 25 (having a new radial velocity of \( V_h = 5205 \) km/s), LOG 368 (not completely isolated) and LOG 377 (not having a clear optical identification for the radio source HIPASS J1615–17). The updated LOG catalog is presented in Table 1.

The table columns contain:

1. the number of the galaxy in the LOG catalog;
2. the name of the galaxy in the known catalogs;
3. equatorial coordinates for the epoch J2000.0;
4. distance to the galaxy \( D = V_{LG}/H_0 \) in Mpc, determined from the radial velocity relative to Local Group at the Hubble parameter \( H_0 = 73 \) km s\(^{-1}\) Mpc\(^{-1}\); the cases of use of individual distance estimates presented in the NED database are marked by an asterisk in the last column;
5. apparent magnitude of the galaxy in the B-band;
6. total Galactic and internal extinction in the B-band;
7. morphological type by de Vaucouleurs scale;
8. index of the average surface brightness of the galaxy: H for high, N for normal, L for low;
9. logarithm of the apparent axial ratio;

\[ A_B = (1.54 + 2.54(\log 2V_m - 2.5)) \log(a/b) \]  \( (3) \)

through the apparent galaxy axis ratio \( a/b \) and the amplitude of internal rotation \( V_m \) [11]. For the dwarf galaxies with \( V_m < 39 \) km/s and gas-poor E, S0 galaxies, internal extinction was considered negligible.

We have checked each galaxy of the LOG catalog in the NED database for the presence of the FUV ultraviolet flux in the \( \lambda_{\text{eff}} = 1539 \) Å, FWHM = 269 Å) band from measurements of the GALEX orbital telescope [2, 3]. In frequent occasions, when the FUV image of the galaxy was split into several condensations, we have summed the \( F_{UV} \) flux throughout the optical disk of the galaxy.

To determine the global rate of star formation in the galaxy, SFR, we followed the scheme used in Lee and et al. [9]:

\[ \log(SFR [M_\odot/yr]) = \log F_{UV}^c + 2 \log D - 6.78, \]  \( (1) \)

where \( D \) is the distance to the galaxy in Mpc, and the flux \( F_{UV} \) in mJy is corrected for the extinction of light

\[ \log(F_{UV}^c/F_{UV}) = 0.772(A_B + A_B^i). \]  \( (2) \)

Here, the value of Galactic extinction in the B-band, \( A_B^G \), was taken according to [10], and internal extinction in the galaxy itself was determined as

\[ A_B = (1.54 + 2.54(\log 2V_m - 2.5)) \log(a/b) \]  \( (3) \)

http://edd.ifa.hawaii.edu
Table 1. Parameters of isolated galaxies in the LOG catalog

| LOG | Name | RA (J2000.0) | Dec | D | B | A_p^2 | T | SB | log(a/b) | K_c | log FUV | log F_H | W_50 | log SFR | log M_0 | P | F | Note |
|-----|------|--------------|-----|---|---|-------|---|----|---------|------|---------|--------|------|--------|--------|---|---|------|
| 1   | ESO149−013 | 002463.3−524618 | 18.67 | 15.39 | 0.20 | 8 | N | 0.40 | 12.59 | 2.70 | 1.06 | 98 | −1.38 | 8.82 | −0.06 | 0.48 |
| 2   | ESO149−018 | 007145.5−523712 | 23.89 | 15.78 | 0.13 | 9 | N | 0.10 | 13.30 | 2.57 | 0.74 | 103 | −1.35 | 8.75 | 0.04 | 0.35 |
| 3   | UGC00064 | 007440.0+405232 | 7.59 | 15.5 | 0.36 | 10 | N | 0.10 | 12.79 | 2.93 | 1.24 | 60 | −1.82 | 7.96 | 0.37 | 0.31 |
| 4   | UGC00063 | 007508.8−355759 | 9.79 | 15.34 | 0.27 | 10 | N | 0.18 | 12.72 | 2.61 | 0.28 | 42 | −1.98 | 8.21 | 0.04 | 0.27 |
| 5   | ESO538−024 | 010175.8−181551 | 19.3 | 15.08 | 0.14 | 8 | N | 0.07 | 12.34 | 3.06 | 0.92 | 25 | −1.05 | 8.95 | 0.15 | 0.04 |
| 6   | PGC130903 | 01108.7−385015 | 43.56 | 15.36 | 0.07 | 6 | H | 0.29 | 12.20 | 2.46 | 0.3: | 6 | −0.99 | 9.71 | 0.56 | 0.06 |
| 7   | 6dF... | 01408.3−353648 | 44.77 | 16.25 | 0.14 | 9 | H | 0.43 | 13.40 | 2.37 | 0.71 | 117 | −0.92 | 9.25 | 0.03 | 0.42 |
| 8   | SDSS... | 01500.1−110804 | 47.49 | 17.8 | 0.16 | 6 | N | 0.65 | 14.54 | 1.54 | 0.3: | 6 | −1.74 | 8.85 | 0.45 | 0.89 |
| 9   | ESO241−027 | 01502.7−431731 | 44.32 | 15.68 | 0.03 | 6 | H | 0.16 | 12.55 | 2.57 | 0.05 | 6 | −0.89 | 9.58 | −0.33 | −0.27 |
| 10  | 6dF... | 01550.9−225511 | 44.01 | 15.78 | 0.18 | 6 | N | 0.26 | 12.50 | 2.54 | 0.56 | 89 | −0.81 | 9.60 | 0.27 | 0.15 |
| 11  | ESO194−002 | 01830.4−473921 | 19.63 | 16.12 | 0.05 | 7 | L | 0.09 | 13.22 | 2.39 | 0.14 | 46 | −1.77 | 8.61 | −0.23 | −0.01 |
| 12  | AM0016−575 | 01909.3−573830 | 22.41 | 15.36 | 0.18 | 9 | N | 0.11 | 11.08 | 2.57 | 1.32 | 141 | −1.37 | 9.58 | −0.81 | 0.88 |
| 13  | UGC00198 | 02051.8+125122 | 27.60 | 17.3 | 0.34 | 8 | L | 0.04 | 14.36 | 2.16 | 0.62 | 94 | −1.47 | 8.45 | 0.22 | 0.47 |
| 14  | ESO150−005 | 02225.6−533851 | 15.15 | 13.99 | 0.18 | 8 | N | 0.15 | 11.21 | 3.31 | 1.14 | 103 | −0.97 | 9.19 | −0.02 | −0.03 |
| 15  | NGC0101 | 02354.6−323210 | 46.73 | 13.46 | 0.14 | 6 | N | 0.04 | 12.22 | 3.40 | 1.07 | 160 | 0.07 | 10.56 | −0.35 | −0.16 |
| 16  | UM240 | 02507.4+001846 | 46.53 | 17.5 | 0.10 | 9 | H | 0.12 | 15.05 | 1.85 | 0.3: | 6 | −1.51 | 8.63 | 0.00 | 0.64 |
| 17  | 6dF... | 02755.3−031101 | 46.19 | 15.8 | 0.15 | 6 | H | 0.04 | 12.55 | 2.67 | 0.46 | 40 | −0.66 | 9.62 | −0.14 | 0.05 |
| 18  | UM040 | 02826.6+050016 | 20.86 | 15.3 | 0.13 | 9 | N | 0.18 | 12.82 | 2.81 | 0.80 | 91 | −1.23 | 8.82 | 0.09 | 0.16 |
| 19  | UGC00285 | 02851.1+258622 | 33.26 | 15.55 | 0.38 | 4 | N | 0.52 | 11.57 | 2.27 | 0.30 | 106 | −1.18 | 9.73 | −0.76 | −0.59 |
| 20  | UGC00288 | 02903.6+432554 | 7.68 | 15.64 | 0.33 | 10 | N | 0.21 | 12.96 | 2.53 | 0.72 | 45 | −2.22 | 7.90 | 0.02 | 0.20 |
| 21  | UGC00313 | 03126.1+061224 | 30.64 | 14.35 | 0.26 | 7 | H | 0.23 | 11.24 | 2.75 | 0.00 | 116 | −0.85 | 9.79 | −0.50 | −0.68 |
| 22  | HS0029+1748 | 03203.1+180446 | 33.01 | 18.03 | 0.57 | 9 | H | 0.56 | 15.11 | 1.92 | 0.3: | 13.8 | 3.30 | 0.46 | 0.21 |
| 23  | ESO294−020 | 03209.7−401605 | 19.08 | 14.45 | 0.25 | 8 | N | 0.12 | 11.60 | 3.10 | 0.44 | 120 | −0.93 | 9.23 | −0.02 | −0.57 |
| 24  | UGC00328 | 03322.1−010717 | 29.30 | 16.2 | 0.27 | 8 | N | 0.18 | 13.33 | 3.09 | 1.25 | 137 | −0.54 | 8.91 | 0.68 | 0.22 |
(10) apparent magnitude of the galaxy in the $K_s$-band, corrected for Galactic and internal extinction: $K - K^c = 0.085(A_B^G + A_B^H)$; since the majority of galaxies in the LOG catalog relate to the late types for which the 2MASS sky survey greatly underestimates the integral IR fluxes, we determined the $K_s$-magnitude from the $B$-magnitude and the average color index: $\langle B - K \rangle = 4.10$ for the $T < 3$ types, $\langle B - K \rangle = 4.60 - 0.27$ for the $T = 3$–8 types and $\langle B - K \rangle = 2.35$ for $T = 9$–10 according to the recommendations from [12, 13];

(11) logarithm of the total FUV flux of galaxies in [mJy];

(12) logarithm of the flux in HI radio line in [Jy×km/s];

(13) the HI line width on the level of 50% from the peak in km/s;

(14) star formation rate in the galaxies (in the units of solar mass a year), computed from relation (1) accounting for the ratios (2) and (3);

(15) logarithm of stellar mass of the galaxy (in solar masses), determined from the integral $K_s$-luminosity at $\langle M_* / L_K \rangle = 1$ and apparent magnitude of the Sun $M_{K,⊙} = 3.28$ [14, 15];

(16, 17) dimensionless parameters P (Past) and F (Future) that characterize the evolutionary state of the galaxy:

\[
P = \log(\text{SFR} \times T_0 / L_K), \quad (4)
\]

\[
F = \log(1.85 \times M_{HI} / \text{SFR} \times T_0), \quad (5)
\]

where $T_0 = 13.7 \times 10^9$ yrs is the age of the Universe, $M_{HI}$ is the hydrogen mass of the galaxy, $M_{HI} = 2.356 \times 10^2 \times D^2 \times F_{HI}$, and the 1.85 coefficient takes into account the contribution of helium and molecular hydrogen in the total mass of gas [1];

(18) notes on the existence of peculiarities (pec) in the structure of the given galaxy; the asterisk marks the galaxies with individual estimates of distances from the NED.

The complete computer-readable version of Table 1 is accessible from the Strasbourg astronomical Data Center (CDS).

3. SOME INTEGRAL PARAMETERS OF LOG GALAXIES

The main feature of galaxies of the LOG catalog is the abundance among them of objects of late morphological types. The median of distribution of the LOG galaxies by type falls on the Sdm ($T = 8$) type. Owing to this, more than 90% of the sample is detected in the HI line, over 80% of galaxies have their FUV fluxes and, consequently, integral star formation rate estimates.

The three panels of Fig. 1 show the distribution of isolated galaxies from our catalog, by the logarithms of stellar mass, hydrogen mass and star formation rate, respectively. The median values of stellar mass, $2.3 \times 10^8 M_{⊙}$, and hydrogen mass, $1 \times 10^8 M_{⊙}$, show that this sample is dominated by the galaxies of moderate to low mass, but with a high content of the gas component. Individual values of log SFR in the LOG galaxies are distributed in a wide range from $+0.34$ to $-3.67$ with a median of $-1.05$.

As we can see from Fig. 2, the hydrogen mass-to-stellar mass ratio increases systematically from the normal luminosity galaxies to dwarf systems, described by the regression

\[
\log(M_{HI} / M_*) = -0.54 \log(M_*) + 4.65 \quad (6)
\]

with a correlation coefficient $R = -0.76$ and standard deviation SD = 0.40. In some dwarf galaxies about 90% of baryon mass falls to the gas component. Such objects are obviously in the early stages of the process of transformation of their gas into stars.

Figure 3 reproduces the distribution of LOG galaxies by the value of integral star formation rate and hydrogen mass. The solid line in the figure corresponds to the power law $\log \text{SFR} \propto 3/2 \log(M_{HI})$, which was dubbed the Kennicutt–Schmidt law [16]. As we can see, apart from several objects, the majority of isolated galaxies follow the established relation quite well, which looks even clearer if we exclude the early-type galaxies.
Figure 1. Distribution of isolated galaxies by the stellar mass (top panel), hydrogen mass (middle panel) and integral star formation rate (lower panel).

Figure 2. The hydrogen mass-to-stellar mass ratio for the isolated galaxies of different stellar masses.

Figure 3. Integral star formation rate in isolated galaxies of different hydrogen masses. The line represents the Kennicutt–Schmidt power law with the 3/2 exponent.
4. SPECIFIC STAR FORMATION RATE AND GAS RESERVES IN THE GALAXIES

An important characteristic of a galaxy is the specific rate of star formation, normalized per unit of its $L_K$-luminosity or stellar mass, $SSFR = SFR/M_*$. The variation of this value depending on the stellar mass of the isolated galaxy is presented in Fig. 4. The left panel of the figure denotes the early-type ($T \leq 1$), intermediate ($T = 2–8$) and late-type ($T = 9,10$) galaxies by different symbols. As might be expected, a limited population of E and S0-galaxies has systematically depressed values of log SSFR with the median of $-11.5$. The subsystem of disk galaxies of Sab–Sdm types is characterized by an order of magnitude larger median value, $-10.3$, and shows a trend of decreasing average star formation rate with increasing stellar mass of the galaxy. Low-mass galaxies of the latest types: Ir, Im, BCD have a median of log SSFR $= -10.1$ [yr$^{-1}$], comparable with the value of the Hubble constant, log $H_0 = -10.14$ [yr$^{-1}$].

The right panel of Fig. 4 presents the same distribution of 428 isolated galaxies by log SSFR and log $M_*$, given with galaxies marked with the indices of mean surface brightness. The highest SFR with a median of $-10.0$ holds for the galaxies of low surface brightness, whereas in the galaxies of normal and high surface brightness the medians log SSFR are $-10.2$ and $-10.4$, respectively.

As noted in [17], the SSFR in galaxies of various types of mass and structural types does not exceed some maximum value of log SSFR$_{\text{max}} \simeq -9.4$ [yr$^{-1}$]. This limit is indicated in Fig. 4 by a dotted line. Just one isolated galaxy, LOG 58 = UGCA 20, is located above this line. However, the error in determining its apparent magnitude is around $0^m5$, and in actual fact this irregular galaxy of low surface brightness can be located below this limit. The presence of the upper limit in the rates of transformation of gas into stars in the galaxies is an important parameter of this process, similar to the Eddington limit for stellar luminosity.

It is convenient to characterize the evolutionary status of galaxies by the dimensionless parameters P (Past) and F (Future), which are independent of the galaxy distance measurement errors [18, 19]. The diagnostic diagram (P, F) for the isolated galaxies is presented in Fig. 5. On its left panel, the LOG galaxies are divided into three categories based on morphological types: (E-Sa), (Sab-Sd) and (Im, BCD, Ir), while on the right panel they are sorted by the index of average surface brightness: high, normal, low.

According to the relations (4) and (5), the galaxy located in the center of the diagram ($P = 0$, $F = 0$) is able to reproduce its observed $L_K$ luminosity (stellar mass) during the Hubble time at the currently observed star formation rate; and the gas reserves in it are sufficient to support the observed SFR on the scale of yet another Hubble time.

The median values of the parameters P and F for the galaxies of the above categories are listed in Table 2. As follows from these data, in general the population of isolated galaxies is concentrated towards the origin ($P = 0$, $F = 0$) with the typical spread of $\sigma(P) \simeq \sigma(F) \simeq 0.6$. This means that on the average the current star formation rates in isolated galaxies are in accord with their observed luminosities and their gas reserves are by now exhausted only half-way.

The variations of median values in Table 2 show that over the past epochs both the early-type galaxies and high surface brightness galaxies have had significantly higher star formation rates than those currently observed. Judging by the trend of the F parameter, the high surface brightness galaxies have already passed half of their evolutionary path, while the objects of low surface brightness are still at the early stage of transformation of gas they have into stars.

| Galaxy type | Median P | Median F |
|-------------|----------|----------|
| $T < 2$     | $-1.41$  | $0.31$   |
| $T = 2–8$   | $-0.11$  | $-0.05$  |
| $T = 9,10$  | $0.09$   | $0.22$   |
| High SB     | $-0.16$  | $-0.15$  |
| Normal SB   | $-0.08$  | $-0.06$  |
| Low SB      | $0.16$   | $0.33$   |
| All types   | $-0.05$  | $0.03$   |
Figure 4. Specific star formation rate and stellar mass in isolated galaxies of different morphological types (left panel) and different classes of surface brightness (right panel). The horizontal line corresponds to the limit $\log \text{SSFR} = -9.4 \text{[yr}^{-1}\text{]}$.

Figure 5. The diagnostic diagram Past–Future of isolated galaxies of different morphological types (left panel) and different classes of surface brightness (right panel).

5. ISOLATED EARLY-TYPE GALAXIES

After the re-classification of morphological types of the LOG galaxies done in three years, we found that in 73% of cases our independent type identifications coincide with each other. The vast majority of the 133 unmatched estimates showed the differences of $\Delta T = \pm 1$, corresponding to the errors of the parameters $\Delta \log L_K = \Delta P = \pm 0.1$, which are barely visible on the diagrams of Figs. 4 and 5.

However, there is a small (about 5%) category of isolated early-type galaxies, classifying which one can easily make a considerable error.
The morphological properties of these galaxies are often conflicting: a smooth distribution of light over the disc and red color are sometimes combined with the presence of emission in the optical spectrum or in the H I line, or with a significant flux in the ultraviolet, like in the Markarian objects.

A list of 28 such galaxies, classified by us as E, S0, Sa is presented in Table 3. The designations of the values therein are the same as in the original Table 1; its last column marks the presence in the galaxy of an infrared IRAS flux (IR). The images of these galaxies sized $2' \times 2'$, taken from the SDSS and POSS-II sky surveys are given in the form of a mosaic in Fig. 6.

This scarce collection of isolated galaxies of types E ($N = 7$), S0 ($N = 12$) and S0–Sa ($N = 9$) has the following features. About 79% of the objects of this subsample are characterized by high surface brightness, and the presence of the FUV flux. Only a quarter of these galaxies is detected in the H I line. About 68% of the objects are the IRAS sources, indicating the presence of dust components in them. The images of some galaxies exhibit low-contrast features of a spiral structure (UGC 5467, UGC 5744), a polar ring (AM 0126–653), or the core emission in $H\alpha$ (SBS 0945+594). These features indicate that among the very isolated galaxies there is a lack of classical E and S0-galaxies with no signs of gas and dust. As it was pointed out previously [7], E and S0 “orphan” galaxies have systematically lower luminosities than the members of groups and clusters of the same types.

The small population of isolated E, S0-systems can be an important indicator of the process of accretion of warm intergalactic gas, which is shielded in the late-type objects by their own activity of star formation [20]. The closest and most expressive example of this special class of galaxies is NGC 404, surrounded by an H I-cloud, the central part and the far
periphery of which have revealed the regions of star formation [21, 22].

6. PECULIAR AND MARKARIAN OBJECTS IN THE LOG CATALOG

As we have already noted [7, 8], the LOG and KIG catalogs of isolated galaxies contain about 5% of peculiar objects having noticeable distortions of the general structure, shape asymmetry or the presence of tidal “tails.” The list of 21 galaxies in the LOG with the enumeration of their anomalies was shown in Table 3 of [7]. It has been suggested that these isolated galaxies could have obtained the peculiarity of their structure as a result of interaction with dark objects with masses comparable to the masses of galaxies themselves. Other possible explanations for these anomalies of the isolated galaxies suggest that the observed structural distortions are caused either by the recent merger of a pair of galaxies, or an asymmetric starburst on the outskirts of a single galaxy. In either scenario, a detailed study of the kinematics of such objects would help to better understand their nature.

The publication of new releases of the SDSS survey adds to the list of peculiar isolated galaxies. In this regard, we draw attention to another two objects: LOG 337 = UGC 9588 = VV 803 and LOG 357 = UGC 9893 = VV 720, the reproductions of the SDSS images of which are presented in Fig. 7. In the first case, the object appears as a pair of blue dwarf galaxies with tails on the stage directly before the merger phase. In the second case, a single blue galaxy seems to be the result of a recent merger of two dwarf systems with the formation of a polar ring in the central part. Since the isolated galaxies reside in very low-density regions, the cases of mergers between them should be extremely rare. However, an example of an interacting triple system in the
nearby void has already been mentioned in the literature [23]. It should be noted that among the 517 galaxies of the LOG catalog there are 18 active objects from the Markarian lists. Their total number in the 11K-sample with radial velocities of $V_{\text{LG}} < 3500 \text{ km/s}$ is 260, hence their relative number among the isolated galaxies is not smaller than among the members of groups and clusters. One would assume that the star formation activity of Markarian galaxies exceeds the quasi-Eddington limit of $\log \text{SSFR}_{\text{lim}} = -9.4 \; [\text{yr}^{-1}]$. Out of 260 Markarian galaxies located in the same volume with the LOG objects, 230 have their FUV fluxes measured. We have estimated their SSFR from these measurements and compared it with integral luminosity $L_K$. (We present and discuss these data in a separate paper). As we can see from the Fig. 8 data, the Markarian galaxies are also located below the critical value $\log \text{SSFR} = -9.4$. This fact reinforces our assertion that the transformation of gas into stars has a physical limitation by rate, and the dimensionless parameter $\text{dex}(P_{\text{lim}}) = T_0 \times \text{SSFR}_{\text{lim}} = 5.5$ is an important characteristic of this process.

7. CONCLUDING REMARKS

In this paper we continue to study the observational properties of isolated galaxies located in the nearby Universe within the radius of about 50 Mpc. Using the GALEX ultraviolet space telescope data on the FUV fluxes of 389 galaxies from the LOG catalog, we have estimated their integral star formation rates SFR. According to our estimates [7], the isolated LOG galaxies are located in the regions where the average local density of matter is about 50 times lower than the global space density. The LOG sample is dominated by the objects of the latest types: Sm, Im, BCD, Ir, rich in gas. The transformation of gas into stars in these isolated galaxies has virtually no influence of the external factors. The SFRs of the LOG galaxies are not very different from the SFRs of other (non-isolated) galaxies having the same morphological types. At the same time, the gas reserves in the LOG galaxies are slightly

Figure 7. Reproductions of two peculiar isolated galaxies sized $3' \times 3'$ from the SDSS. North is on top, east is on the left.

Figure 8. Specific star formation rate and stellar mass for the Markarian galaxies in the same volume of the Local Universe. The horizontal line marks the limit of $\log \text{SSFR} = -9.4 \; [\text{yr}^{-1}]$. 

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greater than those of their non-isolated counterparts.

The specific star formation rate in the galaxies of different mass, morphology and surroundings has an upper limit of \( \log \text{SSFR}_{\text{lim}} = -9.4 \text{ yr}^{-1} \), which is an important empirical characteristic of the process of gas transforming into stars. To our knowledge, the presence of this quasi-Eddington limit has not yet obtained a direct physical explanation [24–27]. Although it is quite clear that the rigorous feedback from this process (gas ejected by the supernova explosions and radiation pressure in the conditions of vigorous star formation) should contribute to setting an upper limit for the SSFR.

About 5% of the LOG catalog objects are classified by us as elliptical and lenticular galaxies (E, S0, S0/Sa). The very fact of the presence of this category of galaxies among the particularly isolated objects appears to be a problem, since their origin involves a series of close encounters and mergers of galaxies. In fact, the few representatives of isolated E and S0 galaxies differ from the conventional E and S0 galaxies in groups and clusters by their low luminosity and often a contradictory combination of a smooth shape, red color and the presence of emission lines in the spectrum. If the processes of accretion of warm interstellar gas significantly affect the increase of the size and mass of the galaxies, the isolated E, S0 objects can serve as the most suitable indicators for the study of this process.

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