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INVESTIGATION OF BARRED GALAXIES. VI. A COMPARATIVE STATISTICS OF SB AND SA GALAXIES. THE COLD GAS PROPERTIES

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The gas properties of barred and unbarred spiral galaxies are compared in two complete samples. It is found that two types of spiral galaxies do not differ from each other in atomic and molecular gas contents. On average there is 6 times more HI than H_2 in spiral galaxies and the ratio MH2/MHI decreases from early to late types. The barred and unbarred spirals in general show a similar behaviors of the gas-to-luminosity relationships, but also there are certain differences between them such as correlation of two gas phases (HI and H_2) for unbarred galaxies. It is suggested that different behaviors of two types galaxies are due to the higher star forming activity of barred with respect unbarred spirals. The expected values of HI and H_2 gas contents have been estimated using blue and far-infrared emission.

1. *Introduction*. There is still an active debate on the nature and dependence of star formation activity from the morphology of spiral galaxies in general, and from the bar effect in particular. There are many reasons which indicate that the presence of a bar increases star formation activity in spiral galaxies (see, e.g. [1-3] and references therein, for more detail). For example, it was found that SB galaxies have hotter FIR colors than SA galaxies [1,4,5]. According to [6] the presence of a bar definitely affects the degree of star formation rate (SFR) in early but not in late types of spirals. Devereux [7] noted that the presence of bars is strongly correlated with the concentration of emission at 10 micron.

Giuricin et al [8] realized that barred spirals are brighter at 10 micron than unbarred systems, essentially because they are more frequently contain HII region-like nuclei. For SB galaxies there are tight correlation between luminosities in FIR, radio and X-ray ranges [2]. The radio spectral indices of SA and SB galaxies between 1.4 and 5 GHz are the same. However there are certain connections between spectral index of SB galaxies and their FIR and X-ray luminosities, namely with increasing of both luminosities the spectral index increases. It is suggested that this may be caused by existence of a bar, which stimulates star formation process in SB galaxies. Arsenault [9] found an enhancement of star formation rate in barred galaxies according to H_α observations. There is a higher degree of formation of massive stars in galaxies of SB0-SBbc than in ordinary degree of formation of massive stars in galaxies of SB0-SBbc than in ordinary spirals [10]. According to Phillips [11], in general, global SFR and other properties of barred galaxies are consistent with unbarred spirals of comparable Hubble class. But in barred spiral of SBb-SBc types the effect of the bar on star formation is clearly seen in the distribution of star forming sites.

There are contradictory results and opinions, for example, observations by Devereux et al [12] of a sample of nearby, relatively faint galaxies at 10 micron show no intense emission in the regions of SB galaxies near the nucleus. Eskride and Pogge [13] argued that the presence or absence of bars does not affect the SFR in S0 galaxies. Moreover, Isobe and Feigelson [14] found that barred galaxies in a volume-limited sample have lower overall FIR luminosity than unbarred galaxies. No bar effect was found in the near-IR [15].

It seems likely that large scale galaxy environment (i.e. galaxy group) does not affect by presence or absence of a bar. However, group and non-group barred galaxies may differ by star formation activity [3].

Another important constituent of star formation is gas content. However gas properties of barred galaxies with respect unbarred ones are less studied. Present paper deals with neutral hydrogen ($\lambda = 21$ cm) and molecular hydrogen (estimated from ^{12}CO (1-0), $\lambda = 2.6$ mm line observation) gas content of barred and unbarred galaxies, as well as H_α ($\lambda = 6462$ A) line.

2. *Samples of Barred and Unbarred Galaxies*. Kandalyan and Kalloghlian [16] have compiled a magnitude-limited ($13^m.5$) sample of barred and unbarred galaxies. The catalog of barred galaxies contains a total of 690 SB + SAB objects north of $\delta = -10°$. The list of unbarred galaxies contains a total of 456 objects north of $\delta = +30°$. The optical and FIR luminosity functions of these galaxies are discussed in [1,3]. For the present study we have used these samples of spiral galaxies.

The main parameters of these galaxies, including HI ($\lambda = 21$ cm) data have been extracted from the LEDA and NED[1] database. The ^{12}CO (1-0) line data are from [17-23]. The H_α line data are from [24-26]. The FIR, blue, radio and X-ray luminosities have been calculated according to formulas presented in [1,2]. The total MHI and MH2 masses have been calculated according to formulas:

$$\log (MHI/M_\odot) = 5.372 + \log F(\text{Jy km s}^{-1}) + 2\log D\ (\text{Mpc}),$$

where F is the integral line intensity and D is the distance of the galaxy.

$$\log (MH2/M_\odot) = 0.679 + \log (L_{CO}/L_\odot)$$

for the molecular hydrogen to CO conversion factor $N(H_2)/I_{CO} = 3\cdot 10^{20}\,\text{cm}^{2}$ (K km s^{-1})$^{-1}$, where I_{CO} is integral CO line intensity in K km s^{-1} [27]. The CO line

[1]The NASA-IPAC Extra-galactic Database (NED) which is operated by the Jet Propulsion Laboratory, Caltech, under contract with the National Aeronautics and Space Administration (USA).

luminosity has been calculated according to:

$$\log(L_{CO}/L_{\bullet}) = 1.425 + \log I_{CO}(\mathrm{K\ km\ s^{-1}}) + 2\log\theta\ (\mathrm{arcsec}) + 2\log D\ (\mathrm{Mpc}),$$

where ϑ is beam-size of the telescope at 2.6 mm. The H_{α} luminosity has been calculated according to

$$\log(L_{H_\alpha}/L_{\odot}) = 16.496 + \log f_{C}(\mathrm{erg\ cm^{-2}\ s^{-1}}) + 2\log D\ (\mathrm{Mpc}),$$

where f_C is the flux density corrected for Galactic and internal absorption. The distance D of a galaxy has been calculated from the galaxy virgo-centric radial velocity for the Hubble constant $H_0 = 75$ km s^{-1} Mpc^{-1}. All calculated luminosities and masses are in solar units. For the radio telescopes at 2.6 mm have been accepted following beam-sizes: IRAM 30m (23 arcsec); Onsala 20m (33 arcsec); SEST 15m (44 arcsec); FCRAO 14m (45 arcsec); NRAO 12m (55 arcsec); Bell Lab. 7m (100 arcsec).

3. *Comparison of barred and unbarred galaxies.* 3.1. *The mean values of MHI, MH2 and $L_{H\alpha}$ for SB and SA galaxies.* There have been a lot of studies concerning of star formation in the spiral galaxies ([28, 29] and references therein). The cold neutral component of interstellar medium of spiral galaxies consists of two phases: atomic and molecular. These two phases are important constituents of star formation, although probably the molecular phase is more tightly connected with star formation activity than the atomic phase. There are many studies, which have shown that star formation activities of spiral galaxies depend on morphological types. For this reason we will compare calculated parameters of barred and unbarred galaxies among different morphological subtypes.

The spiral galaxies have been divided into three subgroups: early type (S0/a-Sa), intermediate type (Sb-Sc?) and late type (Sc-Irr). Table 1 presents the mean values of log MHI, log MH2 and $\log L_{H_\alpha}$ for barred and unbarred galaxies for each morphological subgroup. The number of galaxies and standard error of means are also indicated. From the data of Table 1 it can be seen that, first, there are not any differences in the gas contents and H_α luminosities between barred and unbarred galaxies for each subgroup and for whole samples as well. Second, the atomic hydrogen content increases from early to late types, while molecular hydrogen content and H_α luminosity decrease regardless the galaxy is a barred or unbarred one. Such behavior in spiral galaxies leads to a strong decrease of the MH2/MHI ratio when going from early to late types [18, 30, 31]. Casoli et al [31] found that between Sa and Sc the ratio MH2/MHI is almost constant and shows a marked decrease from Scd to Irr. According to our results (Table 1 and Fig.1) the MH2/MHI ratio increases slightly from early to intermediate subgroup (up to Sc) and then decreases significantly for the late types, either for barred or unbarred galaxies. It should be noted that for all morphological types the H_2 content is always less than HI content (see, also [31]). In the mean $\log(\mathrm{MH2/MHI}) = -0.83 \pm 0.06$ for barred and log

Table 1

MEAN PARAMETERS OF BARRED AND UNBARRED GALAXIES

Morph. Type	log *MHI*	N	Std. error	log *MH2*	N	Std. error	log L_{H_α}	N	Std. error
SB0/a - SBa	9.16	94	0.08	8.56	39	0.13	5.66	32	0.18
S0/a - Sa	9.06	59	0.09	8.47	18	0.20	5.53	16	0.23
SBb - SBc	9.59	281	0.03	8.84	84	0.08	5.67	86	0.08
Sb - Sc	9.61	115	0.06	8.68	32	0.16	5.37	34	0.16
SBc - Irr	9.26	168	0.04	7.96	29	0.18	4.98	43	0.13
Sc - Irr	9.18	36	0.14	7.43	5	0.56	4.85	5	0.97
All SB	9.41	543	0.03	8.60	152	0.07	5.48	161	0.07
SA	9.38	210	0.05	8.50	55	0.13	5.37	55	0.14

(MH2/MHI) = -0.68 ± 0.09 for unbarred ones. Thus for our sample of spiral galaxies the molecular gas phase content is almost 6 times less than the content of atomic gas phase. This result, in general, is in agreement with the results of Sage [18] and Casoli et al [31], but contradicts with the result of Young and Knezek [30] who found that amounts of molecular and atomic gas contents are equal. Furthermore, Young and Knezek [30] and Sage [18] argue that the observed MH2/MHI decrease is not due to decreasing MH2 as a function of spiral types. However this is not the case for our samples of spiral galaxies (Table 1, see also [31]). Thus we can state that, in general, both phases of the cold neutral interstellar gas in spiral galaxies, either atomic or molecular, depend on the morphology. Young et al [24] found that H_α surface brightness of early types (Sa-Sb) is lower

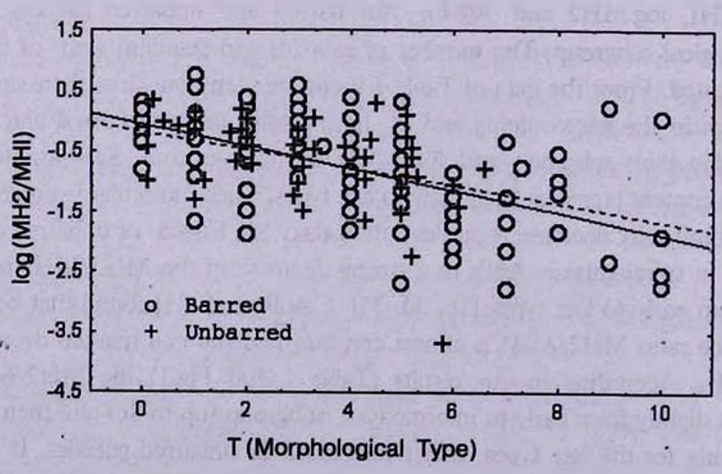

Fig.1. Variation of the molecular to atomic gas mass ratio with the morphological type. Designations of types are from the RC3. The solid and dotted lines are the linear fits to data of barred and unbarred galaxies respectively.

than that of Sbc-Irr. However we found opposite trend for our sample. It was mentioned above that according to our results there are no differences between mean H_α luminosities of barred and unbarred galaxies for each morphological group, as well for whole sample. Ho et al [25] found that for HII nuclei type galaxies early type barred spirals (S0/a-Sbc) exhibit higher star formation rates than unbarred ones, as indicated by either luminosity or equivalent width of H_α emission. However Contini et al [26] do not find any significant difference between the total H_α luminosities of early type and late type for the sample of Markarian-IRAS galaxies, contrary to what occurs in early HII nuclei [10] and for our samples of spiral galaxies (Table 1).

To verify the similarities or differences between two samples (barred and unbarred galaxies) we compare cumulative distributions of MHI, MH2 and L_{H_α}. Fig. 2.3, 4 present cumulative distributions of MHI, MH2 and L_{H_α} respectively for barred and unbarred galaxies. It is seen that these samples do not differ from each other, neither by the cold gas content (HI, H_2) nor by the hot gas content (H_α). Huang et al [6] found that for luminous infrared galaxies ($L_{FIR}/L_B > 0.3$) barred and unbarred galaxies show significant differences in cumulative distributions of atomic hydrogen, and in the mean the HI content of barred galaxies is 1.9 times higher than that of unbarred objects. However our analysis does not confirm this result. It should be noted that our statistical analysis of MHI, MH2 and L_{H_α} are not affected by Malmquist bias and we get almost the same observed trends when instead of MHI, MH2 and L_{H_α} their normalized values either to optical area or to blue luminosity of the galaxy were used.

3.2. *Star formation indicator.* FIR to blue luminosity ratio L_{FIR}/L_B, flux densities ratios at 12, 25, 60 and 100 microns (f12/f25, f60/f100) are used

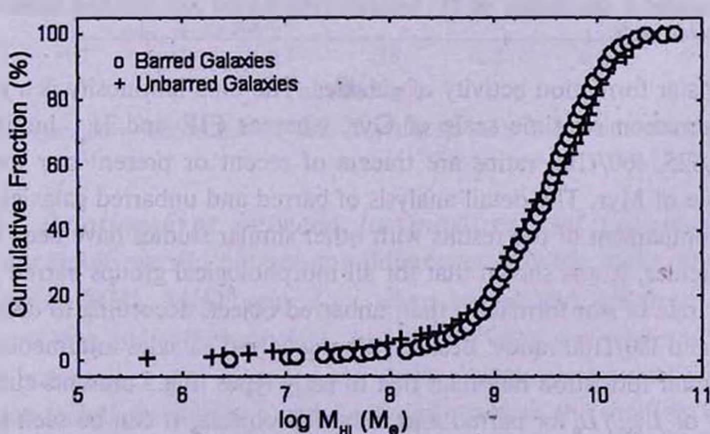

Fig.2. Cumulative distribution of atomic gas content for barred and unbarred galaxies. Gas content is in solar units.

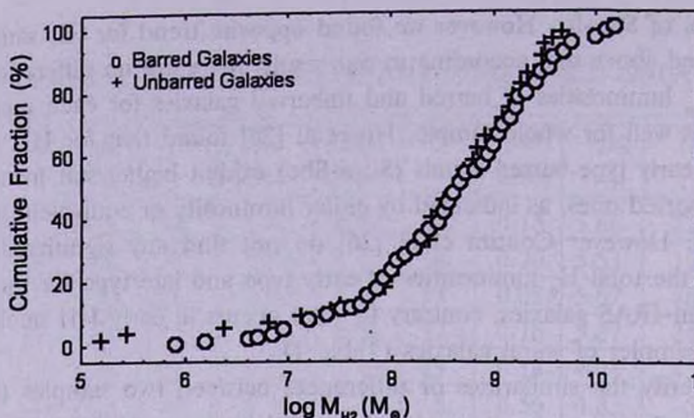

Fig.3. Cumulative distribution of molecular gas content for barred and unbarred galaxies. Gas content is in solar units.

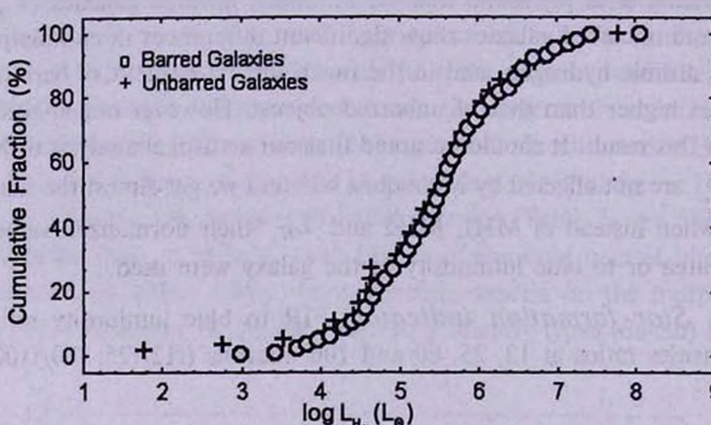

Fig.4. Cumulative distribution of H_α luminosity for barred and unbarred galaxies. Luminosity is in solar units.

to compare star formation activity of galaxies. The blue luminosity is a tracer of past star formation on time scale of Gyr, whereas FIR and H_α luminosities, as well f12/f25, f60/f100 ratios are tracers of recent or present star formation on time scale of Myr. The detail analysis of barred and unbarred galaxies in FIR band and comparison of the results with other similar studies have been done in [1]. In particular, it was shown that for all morphological groups barred galaxies have higher rate of star formation than unbarred objects according to distribution of f12/f 25 and f60/f100 ratios. Besides, among barred galaxies intermediate types have higher star formation rate than that of early types. Fig.5 presents cumulative distribution of L_{FIR}/L_B for barred and unbarred objects. It can be seen that two distributions are almost identical. It means that L_{FIR}/L_B is not a suitable indi-

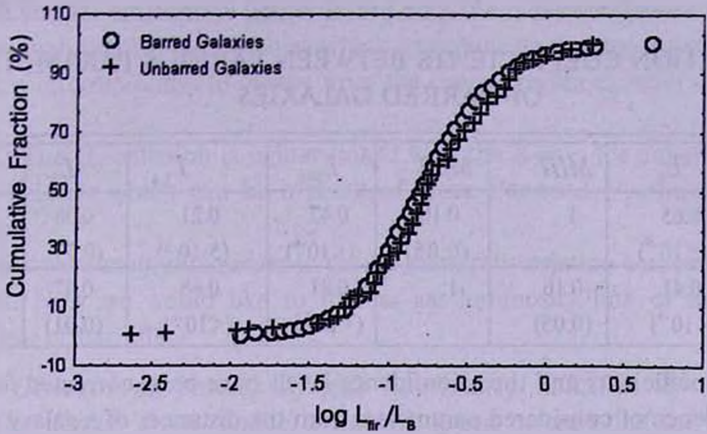

Fig.5. Cumulative distribution of FIR to blue luminosity ratio for barred and unbarred galaxies.

uncertainties of measurements than flux densities. Fig.6 presents cumulative distribution of f60/f100 ratio for early and intermediate types of barred galaxies. Apparently intermediate of types barred spirals are more active in star formation than early types (see, also [1]).

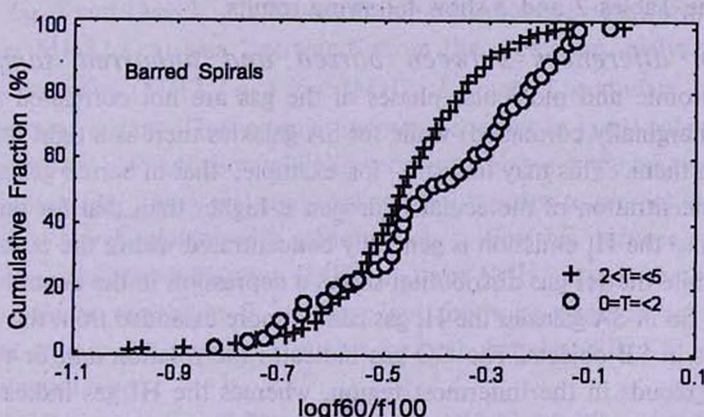

Fig.6. Cumulative distribution of ratio f60/f100 for early and intermediate types of barred galaxies.

3.3. *Relationships between luminosities and gas mass.* According to our results we did not get any differences between mean values and distributions of MHI, MH2, and L_{H_α} when barred and unbarred spirals were considered separately. Nevertheless, in order to know real relationships between various luminosities and masses, our further analysis will deal with multiple regression technique. Tables 2 and 3 present results of this analysis where correlation coefficients between variables and their confidence levels are indicated. All correlation coefficients and their confidence levels have been corrected for arti-

Table 2

CORRELATION COEFFICIENTS BETWEEN VARIOUS PARAMETERS OF BARRED GALAXIES

	L_B	*MHI*	*MH2*	L_{FIR}	$L_{1.4}$	L_X	$L_{H\alpha}$
MHI	0.65 ($<10^{-6}$)	1	0.16 (0.05)	0.42 ($<10^{-6}$)	0.21 ($5\cdot10^{-3}$)	0.08 (0.7)	0.08 (0.3)
MH2	0.41 ($<10^{-6}$)	0.16 (0.05)	1	0.81 ($<10^{-6}$)	0.66 ($<10^{-6}$)	0.47 (0.01)	0.47 (10^{-5})

correlation coefficients and their confidence levels have been corrected for artificial dependence of considered parameters from the distances of a galaxy due to Malmquist bias. We will accept that the observed correlation between two variables is significant if its confidence level is ≥ 0.01. The blue, FIR, radio continuum at 1.4 GHz, X-ray and H_α luminosities are denoted as L_B, L_{FIR}, $L_{1.4}$, L_X and $L_{H\alpha}$ respectively [1, 2]. The neutral atomic and molecular masses are denoted as MHI and MH2 respectively. Tables 2 and 3 reveal differences in behavior of SB and SA galaxies, on one hand, and general relationships between gas phase components and luminosities of spiral galaxies, on the other hand. The analysis of the Tables 2 and 3 show following results.

a) *Main diferences between barred and unbarred samples.*

(i) The atomic and molecular phases of the gas are not correlated for SB galaxies (or marginally correlated) while for SA galaxies there is a tight relationship between them. This may indicate, for example, that in barred galaxies the degree of concentration of molecular hydrogen is higher than that for unbarred objects, because the H_2 emission is generally concentrated within the central few kiloparsecs while the HI gas distribution shows a depression in the central region of the galaxy. So in SA galaxies the H_2 gas can be more extended from the central part than it is in SB objects. The CO gas indicates the rotation and/or velocity dispersion of clouds in the innermost region, whereas the HI gas indicates the rotation and velocity dispersion of the outer disk.

Table 3

CORRELATION COEFFICIENTS BETWEEN VARIOUS PARAMETERS OF UNBARRED GALAXIES

	L_B	*MHI*	*MH2*	L_{FIR}	$L_{1.4}$	L_X	$L_{H\alpha}$
MHI	0.71 ($<10^{-6}$)	1	0.55 (10^{-4})	0.59 ($<10^{-6}$)	0.53 ($2\cdot10^{-4}$)	0.18 (0.4)	0.12 (0.37)
MH2	0.64 ($<10^{-6}$)	0.55 (10^{-4})	1	0.87 ($<10^{-6}$)	0.72 ($<10^{-5}$)	0.61 ($3\cdot10^{-3}$)	0.73 (10^{-5})

(ii) The HI emission is tighter linked with the radio continuum for unbarred galaxies than that for barred ones, which may indicate that bar structure prevents electrons of cosmic rays to escape from the central region to outer disk freely [2, 32].

(iii) The H_2 emission is tighter linked with the X-ray for unbarred than for barred galaxies which can be a result of more extended H_2 emission in these galaxies.

These were main differences in gas-to-luminosity relation between SB and SA galaxies. Now we would like to discuss gas-luminosity link of spiral galaxies regardless of bar effect.

b) *General properties of gas-luminosity relation of spiral galaxies as drawn from Table 2 and 3.* It can be seen that the HI emission is correlated with L_B, L_{FIR}, $L_{1.4}$ but not correlated neither with L_X nor with L_{H_α}. While the H_2 emission is correlated with all luminosities. In order to get what pair of relationship is a primary among the others we have applied multiple regression analysis for both samples. It was found that for spiral galaxies SB and/or SA, relationship between MHI and L_B is a primary while other relationships are product of that. For SB sample (MH2, L_{FIR}) is the primary pair among the others. For SA sample the pair (MH2, L_{FIR}) again is the primary, but the pairs (MH2, L_{H_α}) and (MH2, L_X) have still certain influence when primary correlation (i.e. MH2, L_{FIR}) was "extracted" from the regression analysis. So for SA galaxies the pairs (MH2, L_{H_α}) and (MH2, L_X) are of secondary order, almost with the same weight. Thus atomic hydrogen content in spiral galaxies is tighter related with the blue emission while molecular hydrogen is tighter related with the FIR emission [31]. Now we can use these relationships to predict the HI and H_2 contents of spiral galaxies with some accuracy. For this purpose we have used correlation coefficients between (MHI, L_B) and (MH2, L_{FIR}) from Tables 2 and 3. Using linear regression fit we have got following expressions for expected values of atomic and molecular masses for both samples (SB, SA), including all morphological types.

$\log \mathrm{MHI(expected)} = (0.70 \pm 0.04) \log L_B + (2.35 \pm 0.38)$,

$\log \mathrm{MH2(expected)} = (0.93 \pm 0.05) \log L_{FIR} - (0.14 \pm 0.44)$, for SB sample,

and

$\log \mathrm{MHI(expected)} = (0.77 \pm 0.06) \log L_B + (1.49 \pm 0.55)$,

$\log \mathrm{MH2(expected)} = (1.11 \pm 0.10) \log L_{FIR} - (2.01 \pm 0.85)$, for SA sample.

In section 3 it was argued that there is a dependence of MH1 and MH2 on the morphological type. Thus the estimation expected gas mass in spiral galaxies by using L_B and L_{FIR}, should be done separately for each morphological type because the slope and intercept of linear relation will depend on the galaxy type. However, since for our samples there are not enough data for the CO line (Table 1) to estimate expected molecular mass separately for each morphological types, we have presented expected gas mass for all SB and SA galaxies.

4. *Discussion*. A large number of articles have been devoted to the investigation of the gas properties in galaxies (see, e.g. [28]). Particularly gas-to-luminosity relations of various types of galaxies have been studied extensively. The results of comparison between gas content and luminosity reveals different behavior of the galaxies. For example, in the nearby spirals the HI content is not related with the H_2 content [22] whereas, for the IRAS-selected galaxies there is a tight correlation between them (e.g., [33-35]). In some samples, HI-deficient galaxies show a different relation between HI content and L_{FIR} than it is in HI-normal objects [36]. Thus gas phase-to-gas phase and gas phase-to-luminosity relations in the galaxies are different and very complicated. They depend on many internal and external factors such as environment, luminosity, morphology, gas content, star forming history etc [31]. Of course, the use of different samples in the study of the gas-to-luminosity relation reveals different properties of the galaxies. For instance, IRAS selected samples are biased toward galaxies with recent or present star forming objects while in the optically selected samples dominate past star forming galaxies.

Another important problem is related with star formation indicators. What is the more suitable indicator of star formation activity either past or present? It looks like that spectral indices or flux density ratios, for example, such as f12/f25 and f60/ f100 more correctly reflect star formation activities than global characteristics (luminosities or their ratios) of galaxies (e.g., [1, 2]). Moreover, correlation coefficients between various luminosities may tell us more about star formation activities than the mean values of luminosities. For example, mean luminosities and masses of barred and unbarred galaxies do not differ, but their flux density ratios f12/f25 or f60/f100 deviate significantly [1]. There are also different behaviors in relationships between global parameters of two samples ([2] and Section 3 of the present paper). Besides flux densities are not affected by uncertainties of distance measurements. Observed global parameters of galaxies can be suffered, for instance, by missclassification of SA galaxies and some of them may have weak bars; variation of the CO-H_2 conversion factor from one morphological type to another; differences of spatial resolutions of telescopes at different wavelengths; uncertainties in measured flux densities and magnitudes. But all these uncertainties could not create artificial correlations, and may only add some dispersion to existing relationships and sometimes hide them. However these uncertainties will contaminate the data of both samples (SB and SA) in the same way. Of course, the MH2/MHI ratio for spiral galaxies strongly depends on the CO-H_2 conversion factor. But there are several indications that this factor for spiral galaxies could be even lower than our adopted value of $3 \cdot 10^{20}$ (e.g., [37]). Thus actual H_2 masses could be even lower than we have estimated and the MH2/MHI ratio is even lower than what we find.

Our finding that the HI content in spiral galaxies is better correlated with the blue luminosity than with FIR luminosity is in good agreement with the previous results (see, e.g., [31] and references therein). It is also well known that H_2 content is directly related with FIR luminosity because star formation in the galaxies is taking place inside the molecular clouds. However our finding that for unbarred galaxies there are not negligible relationships between H_2 content, H_α and/or X-ray luminosity, as we know is a new result.

We have also found that there is a tight relationship between two gas phases in SA galaxies, while it is extremely weak in SB objects. Whether presented above results of correlation analysis (Section 3.3) reflect differences in star formation activities between barred and unbarred galaxies? According to observations with high angular resolution in CO lines the molecular gas is concentrated in the central region of barred galaxies, and it is usually distributed along the bar (e.g., [38]). Suppose that in unbarred galaxies molecular gas has larger extend from the central part than in barred galaxies. When both types have the same total molecular gas then in the central parts of barred galaxies it should be more amount of molecular gas than in the central parts of unbarred ones, and consequently molecular gas in the disks of SB galaxies will be less than in the disks of SA objects. Hence in the central regions of SB galaxies star formation activity can be higher than that in SA objects, since star formation is taking place in the molecular clouds, like in our Galaxy. But in that case star formation activity in the disk should be higher in SA galaxies than that in SB ones. On the other hand it is well known that star formation rate and efficiency in the central part of a galaxy are much higher than in the disk. So, as a result star formation activities of barred galaxies will be higher than that in unbarred objects. It seems very likely that the results of correlation analysis support such behavior of barred and unbarred galaxies. In that case the existing tight relationships between (MHI, MH2), (MH2, L_{H_α}) and (MH2, L_X) for SA galaxies are a result of extended structure of molecular gas, since either X-ray, H_α or HI emission in a galaxy also have disk component. Of course there may be other explanations of these properties of barred and unbarred galaxies, but we think that our explanation is more realistic. Further observations with high angular resolution at HI, CO and other wavelengths will help to understand star formation properties of spiral galaxies.

5. *Conclusions*. The main results of this work are summarized in the following:

1. The atomic and molecular gas properties of barred and unbarred galaxies are analyzed using two complete samples. It is shown that in gas content both types of spirals do not differ from each other.

2. In the sample of spiral galaxies, on average, there is 6 times more HI than H_2. The ratio MH2/MHI decreases from early to late types. This variation is due to the increasing of the atomic gas mass and decreasing of the molecular

3. There are different behaviors of gas-to-luminosity relationships between barred and unberred galaxies which may indicate on high star formation activity of barred galaxies with respect unbarred ones.

4. In general HI content in spiral galaxies is better correlated with blue luminosity while H_2 content is tighter related with FIR luminosity. However for unbarred galaxies there are not negligible relationships between H_2 and/or H_α, X-ray luminosities.

5. We have estimated expected value of gas content (HI and H_2) for barred and unbarred galaxies using blue and FIR luminosities.

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ИССЛЕДОВАНИЕ ГАЛАКТИК С ПЕРЕМЫЧКОЙ. VI. СРАВНИТЕЛЬНАЯ СТАТИСТИКА SB И SA ГАЛАКТИК. ОСОБЕННОСТИ ХОЛОДНОГО ГАЗА

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Особенности газовой составляющей в спиральных галактиках с перемычкой и без перемычки сопоставлены в двух полных выборках. Показано, что по содержанию атомарного и молекулярного газа два типа спиральных галактик не отличаются друг от друга. В спиральных галактиках в среднем имеется в 6 раз больше HI, чем H_2, а отношение MH2/MHI убывает от ранних типов к поздним. Галактики с перемычкой и без перемычки в общем показывают одинаковые особенности в соотношениях содержание газа - светимость, но и имеются определенные различия между ними, как, например, имеющаяся корреляция между двумя фазами газа (HI и H_2) для галактик без перемычки. Предполагается, что различные поведения двух типов спиральных галактик обусловлены более высокой звездообразовательной активностью галактик с перемычкой. Ожидаемые значения содержания HI и H_2 оценены, используя светимости в синей и инфракрасной областях.

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