**ON THE ORIGIN OF THE L–Z RELATION FOR LATE–TYPE GALAXIES**

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We consider the roles of two widely invoked mechanisms for the metallicity-luminosity correlation among late-type galaxies: higher astration level and decreasing efficiency of heavy-element loss with increasing luminosity. We find that both mechanisms contribute about equally to the range in oxygen abundance between low ($\log L_B \sim 8$) and high ($\log L_B \sim 10.5$) luminosity galaxies. We also consider the transition from spirals to irregulars, finding that both the oxygen abundance deficiency (indicating the degree of mass exchange between a galaxy and its environment) and the gas fraction vary smoothly along the sequence. Thus, we find no "irregular versus spiral dichotomy".

**On the origin of the L–Z relation.** Twenty years ago Lequeux *et al.* [4] have revealed that the oxygen abundance correlates with total galaxy mass for irregular galaxies. Since the galaxy mass is a poorly known parameter, the luminosity – metallicity (L–Z) relation instead of the mass – metallicity relation is usually considered [11]. It has been found that the characteristic gas-phase abundances (the oxygen abundance at a predetermined galactocentric distance) and luminosities of spiral galaxies are also correlated [12, 13, 3], and this relationship maps almost directly on to the luminosity – metallicity relationship of irregular galaxies [13, 3].

It is widely suggested that the L–Z relation for irregular galaxies is caused by galactic winds of different efficiencies. In other words, the L–Z relation represents the ability of a given galaxy to keep the products of its own evolution rather than their ability to produce metals. On the other hand, it has been found that the astration level is higher in massive irregular galaxies than in dwarf ones [4]. The systematic increase of the astration level with luminosity can also play a role in the origin of the L–Z relationship.

In our works [8, 9] the values of gas mass fraction $\mu$ and oxygen abundance deficiency $\eta$ (which is a good indicator of efficiency of mass exchange between a galaxy and its environments) have been derived for a number of spiral and irregular galaxies. Using these data, the roles of two mechanisms – astration level increasing with luminosity and efficiency of heavy elements loss decreasing – as causes of the L–Z correlation among later-type spiral and irregular galaxies will be examined, along with the transition from spirals to irregulars.

Our data shows that there is a correlation between the gas mass fraction $\mu$ and the galaxy's luminosity, $\mu \sim 0.8$ at $\log L_B = 7$ and $\mu \sim 0.2$ at $\log L_B = 10.5$. At the same time the oxygen abundance deficiency increases with decreasing luminosity over the large interval of luminosity. Then, one can expect that both mechanisms contribute to the effect. The available data allow to distinguish the contribution of the decrease of gas mass fraction with luminosity and the contribution of the decrease of galactic wind efficiency with luminosity to the difference in oxygen abundances of low- and high-luminosity galaxies.

We discuss first the contribution of the gas mass fraction. The relationship between it and galaxy luminosity can be approximated by the linear expression [10]. The oxygen abundance as a function of present-day gas fraction has been computed for closed-box model galaxies using the model of chemical and photometric evolution of galaxies [8]. Within the interval $\mu = 0.2$ to $\mu = 0.8$ the dependence can be well represented by the linear expression [10]. Then, it can be easy found that the variation in oxygen abundance caused by the increase of astration level with luminosity is given [10]

$$12 + \log O/H_{CB} = 6.55 + 0.24 \times \log L_B. \tag{1}$$

This relation can explain the difference in oxygen abundances between a galaxy of luminosity $\log L_B = 8$ and a galaxy of luminosity $\log L_B = 10.5$ around 0.6 dex, while the observed difference is around 1.2 dex. The increase in astration level causes about half of the effect, in agreement with the fact that elliptical galaxies have oxygen abundances exceeding those of comparably luminous dwarf irregulars [11], but not all of it. Thus, it can be concluded that both mechanisms contribute about equally to the range in oxygen abundance between low ($\log L_B \sim 8$) and high ($\log L_B \sim 10.5$) luminosity galaxies.

**Irregulars versus spirals dichotomy.** By tradition, the late-type galaxies are divided into two classes (irregulars and spirals), and these classes of galaxies are investigated individually. In particular, the existing models of chemical evolution of spiral galaxies are quite different from the ones applied to irregular galaxies. In order to reproduce the observational data (mainly for our Galaxy which is a giant spiral) various versions of the infall model, in which an infall of gas onto the disk takes place for a long time, have been suggested for spiral galaxies (see [2, 7] and references therein). The hypothesis of an infall of gas onto the disks of spiral galaxies is confirmed by the observational data. The Magellanic Stream is an excellent example of the present-day capture of the matter by our Galaxy from satellite galaxies. On the other hand, various versions of models in which an ejection of gas from the galaxy takes place, have been suggested for irregular galaxies (see [6] and references therein). The hypothesis of gas outflows from dwarf galaxies is also confirmed by observational data. Outflows of gas have been observed in a number of galaxies [5]. However, from Sc to Im the Hubble sequence is really a luminosity sequence [1]. The morphological properties of galaxies change in a gradual way along a sequence of decreasing luminosity (the bulge-to-disk ratio decreases along a sequence of decreasing luminosity in a gradual manner, and the bulge is lost in faint galaxies; the spiral structure gets more chaotic in fainter galaxies and is also lost) and do not show a sharp line of demarcation between irregulars and spirals (an "irregular versus spiral dichotomy").

The $L_B$ versus $\mu$ diagram and the $L_B$ versus $\eta$ diagram provides a test of whether the properties of late-type galaxies change in a gradual way along a sequence of decreasing luminosity. Our data shows that there are no jump-like variations in astration level and oxygen abundance deficiency in going from spiral to irregular galaxies. Thus, the variations of astration level and oxygen abundance deficiency among late-type spiral and irregular galaxies provide additional evidence that the properties of late-type galaxies change in a gradual way along a sequence of decreasing luminosity.

The more detailed discussion can be found in [10].

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