ON THE ROLE OF GALACTIC WINDS IN THE CHEMICAL EVOLUTION OF IRREGULAR GALAXIES

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The observed oxygen abundances in a number of irregular galaxies have been compared with predictions of the closed-box model for chemical and photometric evolution of galaxies, with the purpose of determination of the deficiency of oxygen abundance in irregular galaxies: this is an indicator of heavy elements loss via galactic winds. We have found that all the irregular galaxies considered have a significant oxygen abundance deficiency within their optical edges. The oxygen abundance deficiency within the optical edge of a galaxy cannot be explained by the mixing of interstellar medium with gas envelope observed outside the optical edge. This confirm the widely used hypothesis that the evolution of irregular galaxy is accompanied by the ejection of a significant part of heavy elements (gas) in the intergalactic medium.

It is widely accepted that irregular galaxies are open systems, and hence that galactic winds had to play a relevant role in their chemical evolution. Models for chemical evolution of irregular galaxies suggested that the galactic wind hypothesis allows to explain the observed chemical properties of these objects (see [6] and references therein). Outflows of ionized gas have been observed in a number of irregular galaxies [4]. However, the hydrodynamic simulations of irregular galaxies lead to conflicting conclusions [1, 10]. Skillman [11] has summarized the arguments for and against galactic wind dominated evolution of irregular galaxies and has concluded that either case, for and against galactic wind dominated evolution of irregular galaxies, is not very strong.

In our work [7], the concept of the oxygen abundance deficiency in galaxies has been introduced as a deficiency of the oxygen abundance observed in the galaxy in comparison to the oxygen abundance predicted by the closed-box model for the same gas mass fraction. Since the bulk of oxygen is produced by short-living massive stars the oxygen abundance in the closed-box system depends on the astration level and does not depend on the star formation history in the system, *i.e.*, there is one-to-one correspondence between oxygen abundance and astration level for a closed-box system. The variations of the value of oxygen abundance in the systems for a given value astration level (or gas mass fraction) can only be caused by the gas exchange between systems and their environments. The excess of oxygen abundance in comparison to the closed-box model of chemical evolution can be caused only by the inflow of over-enriched gas into the galaxy. Since such possibility seems to be unrealistic it can be adopted that the closed-box model gives the upper limit of oxygen abundance in the system with fixed value of gas mass fraction. The gas loss via galactic wind results in the oxygen abundance deficiency. The variations of the value of oxygen abundance deficiency from galaxy to galaxy can only be caused by the variations of efficiency of gas exchange between galaxies and their environments. In turn, the amount of oxygen abundance deficiency can be considered as indicative of the efficiency of mass exchange. The determination of oxygen abundance deficiency in irregular galaxies can clarify the role of galactic winds in the chemical evolution of irregular galaxies.

The variations in oxygen abundance from region to region in the best studied irregular galaxies are within observational errors [5], *i.e.*, radial oxygen abundance gradient is absent in irregular galaxies. Then, the chemical composition of irregular galaxy can be specified by a single parameter. Irregular galaxies can contain a large amount of dark matter [3] which do not take part directly to chemical evolution. The luminous mass rather than dynamical mass should be used in investigation of chemical properties of irregular galaxies. Mass of stars can be derived from the luminosity of the galaxy and stellar mass to light ratio [8].

The size of irregular galaxies in H I is larger than their optical size [9]. This raises the question – what diameter should be considered as defining the edge of irregular galaxies? This is not unrelevant: as it was indicated above the variations of oxygen abundance from region to region in the best studied irregular galaxies are within observational errors [5], a strong evidence that irregular galaxies are well mixed system within the optical diameter. If the zone of the mixing is not bounded by the optical edge but extends to H I edge then the matter outside the optical diameter can contain a significant part of the heavy elements produced by the stars and, therefore, can play an important role in the chemical evolution of the galaxy. Hunter & Gallagher [2] have found that the presence or absence of extended H I envelopes does not appear to be reflected in properties of the optical components of irregular galaxies. They concluded that only the gas within the optical edge plays an important role in the life of a galaxy. Then the optical radius R_{25} will be considered as the edge of irregular galaxies.

The mass of atomic hydrogen measured in the irregular galaxy is usually the total hydrogen mass. For a number of irregular galaxies there are measurements of radial distribution of surface mass density of atomic hydrogen that allows to determine the fraction of H I mass within the optical diameter R_{25}. The values of fraction of H I mass within optical diameter of a galaxy lie in a wide range (from 0.36 for GR 8 to 0.92 for NGC 55) for the considered galaxies. The derived values of oxygen abundance deficiency in irregular galaxies range from ~ 0.5 to ~ 0.9, *i.e.*, all the irregular galaxies show a significant value of oxygen abundance deficiency. For comparison the largest value of oxygen abundance deficiency among the spiral galaxies considered in [7] is equal to ~ 0.57 for the NGC 2403.

Can the oxygen abundance deficiency within optical edge of irregular galaxy be explained by the mixing of interstellar matter with gas outside the optical edge? To study this possibility, the values of oxygen abundance deficiency have been computed under the assumption that all the gas associated with a galaxy is well mixed. In the case when all the gas associated with a galaxy is taken into consideration significant values of oxygen abundance deficiency in irregular galaxies remain.

Thus, it has been found that all the irregular galaxies considered here have a significant oxygen abundance deficiency within their optical edges. The oxygen abundance deficiency within the optical edge of a galaxy cannot be explained by the mixing of interstellar medium with gas envelope observed outside the optical edge. This confirm the widely used hypothesis that the evolution of irregular galaxy is accompanied by the ejection of a significant part of heavy elements (gas) in the intergalactic medium.

The more detailed discussion can be found in [8].

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