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Oxygen and Sulfur Enrichment in Low Metallicity HII Galaxies

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Abstract. We have analysed long-slit spectrophotometric observations of a sample of 35 HII galaxies in the red (6000 Å - 1μm), including the nebular [SIII] lines $\lambda\lambda$9069, 9532Å. Given the uncertainties associated with the [SIII]λ6312Å line and the importance of S^{++} (the dominant ion) in determining the S/H, it is clear that the observations of the strong near-IR [SIII] lines were needed. All these galaxies were observed previously in the blue wavelength range from which we could derive the O/H abundance using the T_e[OIII] temperature.

Key words. Stars: supernovae – Stars: Population III – Galaxies: low metallicity – Galaxies: abundances

1. Introduction

The study of the variation of one chemical element relative to another can provide information on the nucleosyntesis origins of the elements and on the form of the initial mass function (IMF).

Observations of HII dwarf galaxies still provide a direct means of determining the chemical content of the interstellar medium of almost chemically unevolved galaxies, where metal enrichment of the interstelar medium by supernovae has been operating in very low metallicity enviroments. Sulfur and oxygen are both end-products of explosive nucleosynthesis. The sources of oxygen and its abundance are well determined. On the other hand, there is little direct observational evidence regarding the most likely stellar mass range for the sulfur production. It should be emphasized also that substantial uncertainties about the sulfur yields still remain.

Thus, the comparision of sulfur and oxygen abundances can provide some clues about the sulfur nucleosyntesis, and the optimum stellar mass range for the production of sulfur.

Another interesting point, somewhat speculative, is related to the possible role played by Population III stars. The study of S/O and, in particular, its possible deviations from the solar ratio at very low metallicities, could be of special interest. It could shed light on the early metal enrichment by Population III stars, several hundred million years after the Big Bang:

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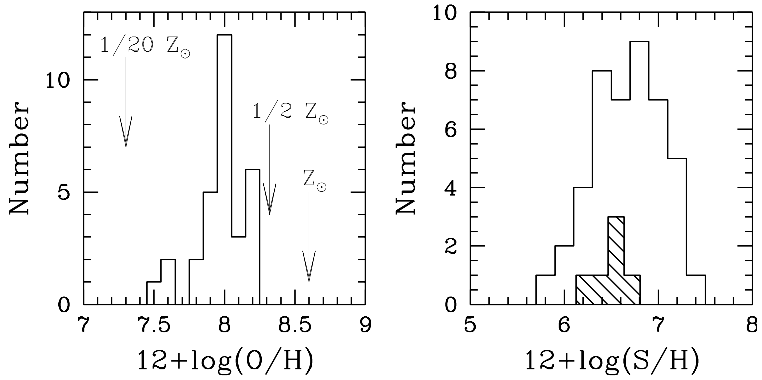

Fig. 1. The oxygen and sulfur abundance distribution for our sample of HII galaxies. On the right panel, the dashed and empty histograms show the number of galaxies with S/H derived from Te[SIII] or obtained from S_{23}, respectively; the oxygen distribution presents only galaxies with O/H derived from Te[OIII].

according to recent zero metallicity stars models the expected value for S/O could reach 1/3 of the solar value (Nomoto et al. 2004).

2. Observations

The data base of this work consits of 35 intermediate resolution spectra of HII galaxies in the wavelength range of 6000 Å to 1μm. For six of the 35 observed galaxies it has been possible to calculate the electron temperature T_e[SIII]. For the galaxies for which we could not measure the auroral [SIII]λ6312Å line, we made use of the empirical abundance indicator S_{23} (Vilchez & Esteban 1996) to estimate S/H (Pérez-Montero et al. 2005). Besides we have spatially resolved distinct star formation knots and extracted their different spectra for 13 galaxies (Kehrig et al. 2004). All these galaxies were observed previously in the blue wavelength range, from which we could derive the O/H through the T_e[OIII] (Kehrig 2003).

Figure 1 shows the distribution of oxygen and sulfur abundances for our sample of HII galaxies. We can see that most of the galaxies present abundance values that are below solar. This is the expected behaviour since our sample is composed by low-metallicity galaxies.

3. Results and Discussion

A close look to figure 2 reveals that there is a rather large scatter (±0.2 dex) in S/H at a given value of O/H. This may reflect uncertainties due to the correction of the near-IR [SIII] lines from atmospheric absorption or to the faintness of the [SIII]λ6312Å line. Up to 10% of the points present S/O values above 3σ of the solar ratio. We are evaluating the contribution of all observational errors to the determination of these points. Nevertheless, at this level of uncertainty, we can conclude that there is no statistical evidence for any systematic variation of S/O with O/H; therefore, our result is in agreement with the current supernovae yields for S and O.

In figure 3, the data show no evidence for any systematic variation of the derived S/H abundance with respect to the ionization structure; confirming the reliability of the empirical method used to derive S/H.

4. Conclusions

We present a study of the variation of S/H as a function of O/H in low metallicity enviroments. The data presented here, together with other studies of S/H based upon the near-IR [SIII] lines, are consistent with the conclusion that S/O remains constant as O/H varies over a large range in metallicity. The scatter, due

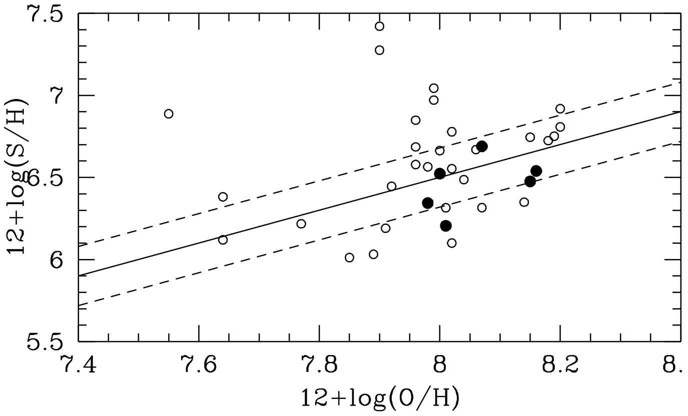

Fig. 2. The relationship between S/H and O/H abundances. Filled circles correspond to S/H obtained using the direct method from Te[SIII]; open circles are S/H derived from the empirical method using the parameter S_{23}. The dashed lines are +/- 1σ of the solar abundance ratio (Lodders 2003) shown by the solid line.

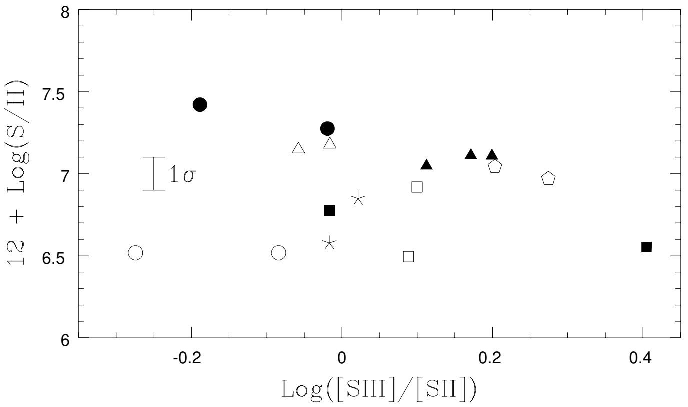

Fig. 3. The S/H abundance versus the [SIII]/[SII] ratio obtained for different locations within an individual galaxies; each galaxy is coded by a different symbol; 1σ is a representative error.

mainly to observational errors, in S/O (at a given O/H) is ±0.3 dex, still large to constrain the degree of variation in S/O expected from popIII nucleosynthesis models.

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