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WHAT IS HAPPENING IN IC 4662?

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RESUMEN

En este artículo presentamos nuevos datos espectroscópicos de tres de las regiones H II más excitadas en IC 4662. En todos los casos la metalicidad se ha obtenido utilizando el método de la temperatura electrónica. Dos de ellas, las llamadas regiones A1 y A2, presentan la misma abundancias en todos los elementos estudiados pero no así la tercera, región D, que tiene valores muy discordantes.

ABSTRACT

We present new spectroscopic data on the three most pronounced H II regions in IC 4662, where the metal content is obtained from the electronic temperature method. Two of these, named regions A1 and A2, present the same chemical abundances for all the elements studied, but the third one, named D, has very discordant abundances.

Key Words: **GALAXIES: DWARF — GALAXIES: IRREGULAR — ISM: ABUNDANCES**

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1. INTRODUCTION

IC 4662 is a moderately studied dwarf irregular (dI) galaxy in the direction of the NGC 6300 group. Its basic parameters from Hidalgo-Gámez & Olofsson (1998) are the distance at 2.5 Mpc, the size which is of the order of 2 kpc at the 25th isophote, and the integrated surface brightness, typically of 21 mag arcsec^{-2}. IC 4662 has been included in a few surveys at different wavelengths where it was found that the optical and the radio major axis of the galaxy were not aligned (Harnett 1987). The work of Heydari-Malayeri et al. (1990) was devoted to this galaxy. They presented Hβ images and spectroscopy of two H II regions, out of a total of five. These H II regions in IC 4662, denoted A1 and A2, are the two largest and seem to be physically connected. The authors concluded that the chemical abundances were identical in A1 and A2.

The existence of a total of five H II regions makes this galaxy a perfect candidate for a more detailed study of possible inhomogeneities in the distribution of the chemical elements in dIs. In order to minimize the uncertainties in the measurement of the chemical abundances, these were obtained using the electronic temperature method only (Osterbrock 1989).

2. OBSERVATIONS AND RESULTS

The spectra presented here were obtained using the ESO 3.6-m telescope at la Silla between the 8th and the 9th of August 1997. The spectrograph used was EFOSC1 with a CCD detector. Two grisms were used during the observations covering a total range in wavelength from 3700 Å to 6800 Å with a resolution of 8 Å and with an overlap between 5100 Å and 5500 Å. Two different slit positions were used in order to obtain data from all the H II regions in the galaxy. The first slit position passed through regions A1 and A2 while the second was positioned such that the slit passed through the regions named B, C, and D (Heydari-Malayeri et al. 1990). The spectra of regions B and C did not present the oxygen emission line, [O III] λ 4363 Å, used for the determination of the chemical composition. Therefore, only data on regions A1, A2, and D are discussed in this paper.

TABLE 1

DERIVED PARAMETERS OF THE H II REGIONS IN IC 4662

	Region A1	Region A2	Region D
T_e, K	$12\,000 \pm 700$	$12\,000 \pm 1000$	$17\,700 \pm 400$
$12 + \log(\mathrm{O/H})$	8.17 ± 0.03	8.17 ± 0.05	7.7 ± 0.1
$12 + \log(\mathrm{N/H})$	6.78 ± 0.07	6.66 ± 0.07	6.1 ± 0.3
$12 + \log(\mathrm{Ne/H})$	7.34 ± 0.02	7.35 ± 0.02	7.2 ± 0.3
$\log(\mathrm{N/O})$	-1.50 ± 0.04	-1.51 ± 0.02	-1.58 ± 0.01

In order to obtain spectra of high signal-to-noise ratio, all the rows with detection of the line [O III] λ 4363 Å were added, which resulted in a one-dimensional spectrum for each region. For more details on the observations, reduction, and analysis procedures, the reader is referred to Hidalgo-Gámez et al. (2001).

2.1. *Results on Chemical Abundances*

Table 1 presents the data on the derived parameters for the three regions studied in IC 4662. The

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chemical abundances in regions A1 and A2 are nearly identical for all the elements studied, except for nitrogen where region A1 seems to be overabundant in this element, although within the uncertainties. Also evident from Table 1 is the large discrepancy found for the abundances in region D, compared to A1 and A2. They are as large as 0.5 dex in oxygen, 0.6 dex in nitrogen, but only 0.1 dex for neon. The differences are, in all cases, larger than the uncertainties associated with the abundance determination.

The similarity between our determination and that of Heydari-Malayeri et al. (1990), which was taken with the same instrumentation, rules out explanations based on the observational method or various methods for the reduction and analysis procedure (see also Hidalgo-Gámez et al. 2001).

3. DISCUSSION

We propose three physical possibilities for the discrepancy between regions A1/A2 and D.

1. The difference in the metallicity is due to temperature fluctuations: Such fluctuations have been detected mainly in planetary nebulae (Liu & Danziger 1993) or Galactic H II regions, such as Orion (Peimbert 1996). González-Delgado et al. (1994) reported large temperature fluctuations in their investigation of NGC 2366. Such large fluctuations could be the cause for differences in the oxygen abundance of 0.4 dex, although our data do not allow a definitive conclusion. The fact that the helium abundance also varies between the regions is an argument against fluctuations in the temperature since the atomic transitions involved are not temperature dependent. The data presented in this analysis does not allow a study of temperature fluctuations.

2. Region D does not belong to IC 4662: There are two arguments favoring this hypothesis. The first is a difference in the radial velocity of 250 km s^{-1} between regions A1/A2 and D. Secondly, as pointed out by Heydari-Malayeri et al. (1990), region D seems not to reside within the ionized gas cloud which encompasses the rest of the galaxy. However, the uncertainties in velocity determinations are high ($\pm$ 150 km s^{-1}) and, also, if region D is a separate object, it must very small, with a radius of less than 200 pc.

3. IC 4662 is not chemically homogeneous: This should be the hypothesis preferred, considering the information obtained so far from this galaxy. Region D seems detached from the rest of the H II regions of IC 4662, at an average distance of 600 pc. As previously mentioned, region D seems not to be part of the ionized gas cloud. If so, region D may not participate in the dynamical evolution of the galaxy. It is clear than the chemical enrichment of the medium is driven by the dynamic evolution of the galaxy (Roy & Kunth, 1995). The consequence would be, if region D is dynamically isolated from the rest of the galaxy, that the chemical abundances could be different, as suggested by data.

4. CONCLUSIONS AND FUTURE WORK

Despite the fact that the chemical inhomogeneity of the galaxy is the most probable cause for the discrepant chemical abundances found in regions A1/A2 and D, neither of the other explanations can be ruled out before a more complete study of the galaxy is undertaken. Spectra containing the Paschen discontinuity are needed in order to study the influence of temperature fluctuations. Also, a detailed study of the dynamics of the gas inside the galaxy will be very useful. Finally, more accurate radial velocity data are needed in other to find out the true origin of region D.

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