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CHEMICAL ABUNDANCES IN PNE IN THE SPIRAL NGC 300[1]

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RESUMEN

Hemos obtenido abundancias químicas para una muestra de más de 20 nebulosas planetarias y varias regiones HII compactas de la galaxia NGC 300, para los cuales se pudo determinar temperaturas electrónicas de [O III], basadas en la medición del cociente [O III]$\lambda\lambda$4363/5007. Estos datos muestra que para las regiones HII existe un claro gradiente de abundancias en el disco de la galaxia. El gradiente es menos empinado y más disperso para el caso de las nebulosas planetarias. Se discuten algunas diferencias entre el comportamiento químico de las nebulosas planetarias y el de las regiones HII.

ABSTRACT

Chemical abundances have been derived for a sample of more than 20 PNe and several compact HII regions in the galaxy NGC 300, for which [O III] electron temperatures have been determined based on the line ratio [O III$\lambda\lambda$4363/5007. The analysis of these data shows a clear abundance gradient for HII regions in the galactic disk. This gradient is flatter and more disperse for PNe. Some differences between HII region and PN abundances are discussed.

Key Words: galaxies: individual (NGC 300) — H II regions — ISM: abundances — planetary nebulae

1. INTRODUCTION

Extragalactic and galactic planetary nebulae (PNe) are most valuable objects to analyze the chemical composition of the interstellar medium (ISM) and some stellar evolution processes in low-intermediate mass stars (LIMS). Interesting problems such as how LIMS enrich the ISM, or the presence of chemical inhomogeneities and abundance gradients in galactic disks can be studied through PNe.

In this work we present a preliminary analysis of a sample of the PN population in NGC 300, a Scd galaxy located in the Sculptor Group, at a Cepheid distance of 1.88 Mpc (Gieren et al. 2005). It is the closest spiral galaxy to the Local Group. Bresolin et al. (2009) have presented a thorough analysis of the chemical behavior of a sample of large HII regions in this galaxy, finding an abundance gradient with a value −0.077 dex/kpc, and a central O abundance of 12 + log O/H $\sim$ 8.57.

We have performed spectroscopic analysis of around 50 compact nebulae (PNe and compact HII regions), selected from [O III]λ5007 on-band off-band pre-imaging of two zones of NGC 300 (central and outskirts zones). Spectral data were obtained with the FORS 2 spectrograph (in multi-object mode MXU) at the Very Large Telescope (VLT) of the European Southern Observatory (ESO) on Cerro Paranal, on August 19–22, 2006. The instrument was used with an aperture of 1 arcsec and several grisms were employed in order to cover a wide wavelength range, from about 3700 to 9500 Å. Data were reduced by using the pipeline provided by the ESO and standard routines of IRAF[6].

From the analysis of these data, physical conditions –electron temperatures and densities– were derived from all the available diagnostic ratios, and ionic abundances were computed for all the objects for which the [O III] electron temperature, based on the detection of [O III]λ4363, was determined. This gave us a sample of more than 20 PNe and more than 10 compact HII regions for which total abundances of O, Ne, Ar, and S were derived by employing the ionization correction factors (icf's) given by Kingsburgh & Barlow (1994).

2. RESULTS

2.1. *Chemical behavior*

By comparing the physical conditions and chemical behavior of our PN sample, our compact HII

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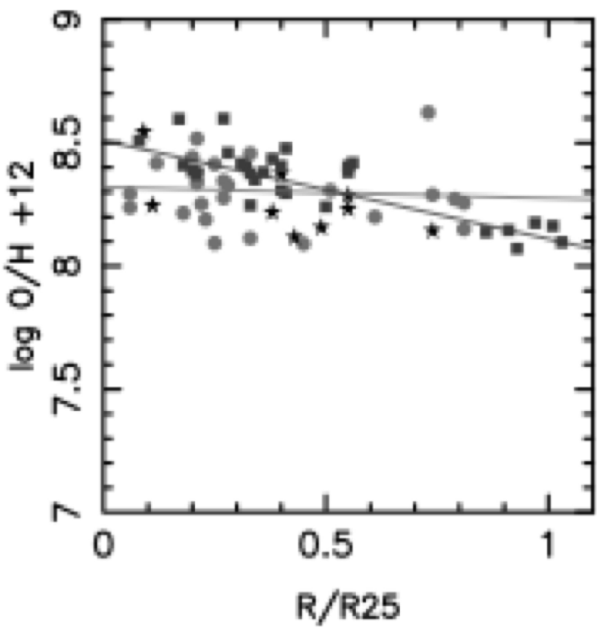

Fig. 1. O/H abundances vs. galactocentric distance for HII regions (filled squares) and PNe (filled circles). The stars correspond to a few compact HII regions. The gradient of O is clear for HII regions (black filled squares), and it is flatter and more disperse for PNe (gray filled circles). Stars represent compact HII regions.

regions and the HII regions analyzed by Bresolin et al. (2009), we have found that, in NGC 300:

1.- PNe and HII regions present a similar range of O/H abundance ratios, with 12+log O/H in the range from about 8.1 to 8.6.

2.- PNe show higher ionization degree (as given by the O^{++}/O^{+} ionic abundance ratios), and higher [O III] electron temperatures and densities, than HII regions.

3.- PNe have lower total Hβ luminosities than HII regions.

Regarding the chemical abundances, PNe present much higher N/O abundance ratio than HII regions (which is expected as LIMS contaminate their atmospheres with nucleosynthesis products, mainly He, N and C) and, unexpectedly, our PN sample seems to have slightly larger Ne/O ratios. This latter could be partially, the effect the ON-cycle operating in the most massive PN central stars, which converts O into N (most probably, we are detecting mainly the most massive and bright PNe). In addition, a possible problem with the ionization correction factor for Ne could be originating this behavior. Other elemental ratios, such as Ar/O and S/O, do not show this problem and are similar in both type of nebulae.

2.2. *Abundance gradients*

We analyzed the possible existence of abundance gradients in the disk of the galaxy. Galactocentric deprojected distances of PNe were calculated in the same way as for HII regions, by assuming R_{25} (the radius at which the surface brightness equals 25 mag$_B$/arcsec^2) equal to 5.33 kpc and an inclination of 39.8 degrees for NGC 300 (Bresolin et al. 2009). Figure 1 shows the behavior of O/H abundance ratio with the galactocentric distance (given in units of R_{25}) for HII regions and PNe. A clear gradient appears for HII regions (already reported by Bresolin et al. 2009) and also a gradient exists for PNe, although it is flatter and less defined. Near the center, PNe seem to have, in average, lower O/H abundance ratios than HII regions. This is not the case in the periphery, where PNe show similar or slightly higher O/H than HII regions.

The lack of a clear O abundance gradient for PNe could be attributable to a mixture of phenomena. In first place, O in PNe could not be representing the original value when the central star was formed as it is known that, in more massive central stars some O depletion can occur during the ON-cycle, or alternatively, in low-metallicity central stars, O can be dredged up during the 3rd. dredge up event (e.g., Peña et al. 2007). This could be affecting the most massive central stars. On the other hand, PNe are a mixture of stellar populations, with ages ranging from several to a few Gigayears, thus, due to the chemical evolution of the interstellar medium in the galaxy, the older PNe were formed in a less enriched ISM than the young PNe, affecting any possible gradient. Besides, older PNe could have migrated from their original position in the galaxy, to a smaller or larger galactocentric distance, affecting then a possible gradient. In this respect, it will be interesting to analyze the behavior of other elements such as Ne, Ar and S.

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