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AN INTERESTING COMPARISON BETWEEN PNE AND H II REGIONS IN NGC 3109 AND NGC 6822

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RESUMEN

Se analizan datos espectroscópicos de nebulosas planetarias y regiones H II de NGC 3109 y NGC 6822, obtenidos con el telescopio ESO-VLT. Se derivan las condiciones físicas y las abundancias químicas en ambos tipos de nebulosas. A partir de regiones H II obtenemos 12+log O/H=7.79±0.15 y 8.10±0.15 para NGC 3109 y NGC 6822, respectivamente. Ambas galaxias son químicamente homogéneas. NGC 3901 es una de las más pobres del Grupo Local. Las nebulosas planetarias en NGC 3901 aparecen más enriquecidas en O que las regiones H II, mostrando que el O ha sido enriquecido por la nucleosíntesis estelar. El neón podría estar afectado por el mismo fenómeno. Esto no ocurre en NGC 6822, donde las planetarias muestran en promedio las mismas abundancias que las regiones H II.

ABSTRACT

Deep spectroscopic data obtained with the ESO Very Large Telescope, of planetary nebulae (PNe) and H II regions in the dwarf irregulars NGC 3109 and NGC 6822, are analyzed. We determined the physical conditions and the chemical composition in both type of nebulae. From H II regions we derived 12+log O/H=7.79±0.15 and 8.10±0.15 for NGC 3109 and NGC 6822 respectively, showing that NGC 3109 is one of the most metal-poor galaxies in the Local Group. Both galaxies appear very chemically homogeneous. Interestingly the PNe in NGC 3109 appear significantly O-richer than the H II regions, indicating that the central stars might have dredged-up some oxygen, enriching the stellar atmosphere previous to the PN ejection. Possibly the neon in the stellar atmospheres has been modified also. This is not the case for NGC 6822 where the PNe show in average the same abundances that H II regions.

Key Words: Galaxies: dwarfs — Galaxies: irregulars — H II regions — ISM: abundances — planetary nebulae

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1. INTRODUCTION

NGC 3901 and NGC 6822 are two dwarf irregular galaxies of the Local Group and its vicinity, whose characteristics resemble the SMC and the LMC respectively. Both show numerous extended and compact H II regions and also many planetary nebulae (PNe) have been detected in them. Due to their distances and positions in the Local Group, these galaxies seem not affected by tidal effects of the Local Group massive galaxies, therefore they are ideal for chemical evolution studies.

NGC 3901 is the dominant galaxy in the Antlia-Sextans group, located at a distance of about 1.33 Mpc. It has a $M_{\rm B} = -15.30$, B$-$V$\sim$0.49, and a metallicity 12+log O/H=7.76±0.33 was reported from a rough analysis of its H II regions by Lee et al. (2003). Recently, Peña et al. (2007a) presented a catalog of emission line objects in this galaxy and reported the discovery of about 20 PN candidates.

NGC 6822 is an Irr IV-V galaxy, located at a distance of 490 kpc. It has a $M_{\rm B} = -15.1$ and the analysis of a few H II regions shows an abundance 12+log O/H=8.10±0.10 (Peimbert et al. 2005; Richer & McCall 2007). Twenty PN candidates were reported by Leisy et al. (2005), some of which have been analyzed by different authors (e.g. Richer & McCall 2007, and references therein).

2. OUR WORK

Deep spectroscopic data were obtained by us, in 2006, for numerous PNe and H II regions in both galaxies. The ESO Very Large Telescope and the Focal Reducer Spectrograph (FORS) in MOS mode were employed for this purpose. From these data we determined the physical conditions and the chemical composition in H II regions and PNe in both galaxies. For all the analyzed objects, the temperature sensitive line [O III] 4363 was observed. Therefore ionic abundances were determined via the classic $T_{\rm e}$-method. Total abundances were derived from the ionic abundances and by correcting for unseeing ions using the ionization correction factors by Kingsburgh & Barlow (1994). See Peña et al. (2007b) for more details.

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NGC 3109. The results for NGC 3109 were reported by Peña et al. (2007b). In this interesting galaxy we found that the H II regions (the ones analyzed by us are distributed all along the galaxy) present a very homogeneous chemical composition with an average value for oxygen 12+log O/H=7.79±0.15. Thus, NGC 3109 is one of the most metal-poor galaxies in the vicinity and very similar in metallicity to its neighbors Sextans A and Sextans B (Kniazev et al. 2005; Magrini et al. 2005). In addition its interstellar medium (ISM) is noticeably homogeneous. Interestingly the PNe analyzed in NGC 3109 appear significantly O-richer than the H II regions, with log O/H+12=8.16 ± 0.19. Similarly to what has been suggested for some of the PNe in the Magellanic Clouds and other metal-poor galaxies, we argue that oxygen in the PNe in NGC 3109 is affected by dredge-up in their progenitors. Evolution models by Marigo (2001) and Herwig (2004) suggest that low metallicity AGB stars ($Z \sim 0.25\ Z_{\rm Sun}$) could dredge-up O during the third dredge-up event. This could also be the case for neon, although the uncertainties for this element are bigger.

NGC6822. Preliminary abundances for some H II regions and PNe in NGC 6822 are presented in Table 1. The data were reduced using IRAF[2] standard procedures and the *nebula* package was used to derive physical conditions and ionic abundances.

When we compare our results with those reported by Peimbert et al. (2005) and Richer & McCall (2007) we find that, similarly to NGC 3109, H II regions in NGC 6822 show a homogeneous chemical composition with 12+log O/H=8.00±0.15. On the other hand PNe present a much more spread O/H range, with 12+log O/H from 7.65 to 8.25. However the average value is 7.96±0.30, in good agreement with the metallicity shown by H II regions. Also the Ne/O average in PNe (equal to 0.20 when including the PNe in Richer & McCall) is similar to the value obtained for H II regions (Ne/O∼0.20 when including the H II regions in Peimbert et al.), therefore the natural conclusion is that PNe in this galaxy, differently from NGC 3109 PNe, have not enriched their O via dredge-up, with the only possible exception of PN 7. This interesting PN shows an extreme N-enrichment. Also He/H is high, thus this object can be classified as a Peimbert's Type I PN. Its low Ne/O is an indication that O could have been dredge-up without effecting the Ne. Similar conclusion were derived by Richer & McCall (2007).

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TABLE 1.

ABUNDANCES IN PNE AND H II REGIONS IN NGC 6822

Obj[a]	T_e[b]	N_e[c]	He/H	O/H	N/O	Ne/O
PN1	1.26	4200	0.105	8.13	0.17	0.17
PN4	1.80	2300	0.110	7.75	0.55	0.19
PN7	1.83	1950	0.128	8.08	9.38	0.10
H II 8	1.18	190	0.105	8.06	0.06	0.25

[a]Objects are named after Leisy et al. (2005).
[b]T_e from [O III] lines (in units of 10^4 K).
[c]Density from [S II] lines.

3. CONCLUSIONS

Our preliminary analysis of the chemical composition of H II regions and PNe in NGC 6822 indicates that PNe have the same abundances as the ISM in this galaxy, contrary of what occurs in NGC 3109 where the PNe are significantly O-richer than the H II regions. So far, the Type I PN 7 seems the only PN in NGC 6822 that could have dredged up O, on the basis of its low Ne/O ratio. However, as Peña et al. (2007b) indicated, O nor Ne are always safe indicators of the ISM abundances at low metallicities. Then it is important to extent the study to many other objects and to determine other elements as Ar or S for a better understanding of this subject.

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