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# CHEMICAL ABUNDANCES OF DWARF SPIRAL GALAXIES

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RESUMEN

Se presentan las abundancias de oxígeno para una muestra de galaxias espirales enanas. En casi todos los casos, ésta se obtuvo mediante los llamados métodos semiempíricos. Los valores de la abundancia que se obtienen son, en la mayoría de los casos, menores que la abundancia solar y muy similares a los que se observan en otras galaxias tardías, como las BCG o las irregulares enanas. Se pudo calcular el gradiente para el caso de cuatro de estas galaxias. En todos los casos, el gradiente es muy grande, siendo mayor que −0.2 dex/kpc para las galaxias no barradas y de −0.1 dex/kpc para la galaxia barrada estudiada.

ABSTRACT

The oxygen abundances of 18 dwarf spiral galaxies are presented. In most of them, the abundance are determined with semi empirical methods. We find that the values are sub-solar for most of the galaxies, similar to those observed in other late-type galaxies, as BCG or dwarf irregular. The abundance gradient can be determined in four of these galaxies, one of them a barred one. The gradients of the three non-barred galaxies in the sample are larger than −0.15 dex/kpc, while the gradient of the barred galaxy is shallower, only −0.1 dex/kpc.

*Key Words:* galaxies: dwarf — HII regions — ISM: abundances



## 1. INTRODUCTION

Although the concept of dwarf galaxy is as old as 1925, it is not until 1995 that the idea of dwarf spiral galaxies is definitively accepted by the astronomical community with the work of Schombert et al. Along all these 70 years, dwarf spiral galaxies have been in and out: Reaves (1956) classified four of the galaxies in the Virgo cluster as dwarf spirals, but after the reorganisation made by de Vaucouleurs of the Hubble sequence the concept of dwarf spiral galaxy almost disappeared from the literature. Edmunds & Roy (1993) concluded that a spiral structure cannot exist for those galaxies less luminous than −17 in the $B$ band. In spite of this, there are 12 galaxies classified as dwarf spiral in the UGC. Hidalgo-Gámez (2004) found that there are at least 111 galaxies less luminous than −18 and smaller than 10 kpc classified as spirals. These are going to be considered as dwarf spiral galaxies (dS).

There are other characteristics in common among these galaxies: they are not located inside large groups and the percentage of barred galaxies is smaller than for normal-size spirals. Also, their colours are as blue as those for dwarf irregular (dI) while the excitation and the ionisation ratios are lower. These properties indicate, on one hand, that the stellar population of dS and dI are similar but, on the other hand, the massive stars should be less massive in dS.

## 2. CHEMICAL ABUNDANCES

From the 111 dS galaxies tabulated in HG04 the abundance were determined only in 18 of them. In all the cases, but in three (one H II region in UGC 6377, the galaxies UGC 9018 and UGCA 294) in which the standard method was used, the abundances were determined using the semi empirical methods. This is the normal situation for spiral galaxies, where the auroral lines needed for the electronic temperature determination are not detected in the spectra.

The oxygen abundance determined for these 18 galaxies are shown in Table 1. The abundance of six of these galaxies were determined using spectra from the SDSS, marked with a star in the table. It is interesting to notice that the oxygen abundance are sub-solar for most of the galaxies. This is particularly important for two of the galaxies from the SDSS (UGCA 294 and UGC 9018) because their spectra are from the highest S/N location in the galaxy which is not necessarily at the outskirts part of them. Then, it might be a indication that the metallicity is sub-solar everywhere in the galaxy, which is not normal for spiral galaxies. Instead, the abundance values are very similar to those of irregular galaxies. Only two H II regions in the center of UGC 5296 and UGC 6205 and four of the SDSS galaxies show larger

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TABLE 1

CHEMICAL ABUNDANCE OF *d*S GALAXIES

| Galaxy | 12+log(O/H) | Method & (Ref.)[a] |
|---|---|---|
| UGC 191 | 8.14 | $R_{23}$ (1) |
| UGC 11820 | 7.9 or 8.2 | $R_{23}$ (1) |
| UGC 891 | 8.2 | $R_{23}$ (1) |
| UGC 5716 | 8.3 | $R_{23}$ (1) |
| UGC 5675 | 7.7 or 8.4 | $R_{23}$ (2) |
| NGC 3985 | 7.2 or 8.9 | $R_{23}$ (3) |
| NGC 2188 | 7.7 or 8.4 | $R_{23}$ (4) |
| DDO 204 | 7.9 to 8.1 | $R_{23}$ (4) |
| UGC 5242 | 7.9 to 8.3 | $R_{23}$ (5) |
| UGC 5296 | 7.4 to 8.9 | $R_{23}$ (5) |
| UGC 6205 | 7.7 to 8.7 | $R_{23}$ (5) |
| UGC 9597* | 8.96 | $R_{23}$ (6) |
| UGC 7780* | 9.04 | $R_{23}$ (6) |
| UGC 7861* | 9.18 | $R_{23}$ (6) |
| UGC 8285* | 8.91 | $R_{23}$ (6) |
| UGC 6377 | 7.9 | $T_e$ (5) |
| UGC 9018* | 8.03 | $T_e$ (6) |
| UGCA 294* | 7.68 | $T_e$ (6) |

[a]References: (1) van Zee et al. (1997); (2) McGaugh (1994); (3) Gallagher & Hunter (1989); (4) Hidalgo-Gámez (2004); (5) Hidalgo-Gámez et al. (2011a); (6) Moranchel-Basurto (2011).

TABLE 2

ABUNDANCE GRADIENTS FOR *d*S GALAXIES

| Galaxy | Accepted gradient |
|---|---|
| UGC 6205 | $-0.3 \pm 0.03$ |
| UGC 6377 | $-0.2 \pm 0.02$ |
| UGC 5296 | $-0.4 \pm 0.1$ |
| UGC 5242 | $-0.17 \pm 0.06$ |

See Hidalgo-Gámez et al. (2011b) for a detailed discussion on the gradient determination.

abundances than solar. In particular for the SDSS galaxies, the abundances are quite large. If the low-metallicity branch were used instead, an abundance lower than 7.3 is obtained.

### 2.1. *Abundance gradients*

Edmunds & Roy (1993) obtained that the gradient dismisses as the absolute magnitude decreases while Zaritsky et al. (1994) obtained the stronger abundance gradients for Sc and Sd galaxies. Consequently, it might be expected that the gradients

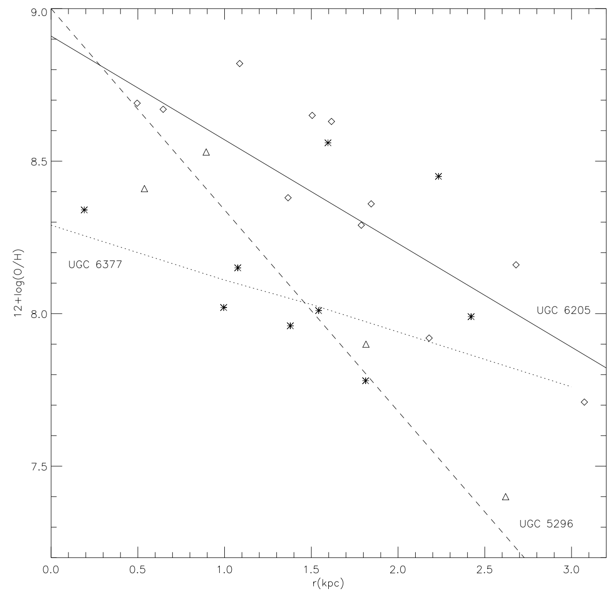


Fig. 1. Abundance gradients for the non-barred galaxies of Table 2. Triangles and the dashed line stand for the data-points of UGC 5296, diamonds and the dotted line for those of UGC 6205 and stars and the solid line for UGC 6377.

for dS galaxies were very shallow, if any. To check this, the gradient were be determined for four of the galaxies in Table 1 for which the galactocentric distances of the H II regions were measured (Hidalgo-Gámez et al. 2011b). The results obtained are opposite to this trend: the slopes are between $-0.17$ and $-0.5$ dex/kpc. There is no differences in the slope between the internal part of the galaxies and the external ones, as observed in another galaxies as M33 (Vílchez et al. 1988).

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