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SPECTROSCOPY OF H II DWARF GALAXIES IN THE VIRGO CLUSTER

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RESUMEN

Se ha realizado un estudio espectrofotométrico de una muestra de galaxias enanas H II en el cúmulo de Virgo. Se ha obtenido espectroscopía óptica de rendija larga para 25 galaxias enanas azules, seleccionadas en el campo central de Virgo, con el fin de entender el papel del ambiente en la evolución de las galaxias enanas. Esta muestra es un subconjunto de una lista mayor de galaxias enanas para la cual se cuenta con imagen profunda en Hα. Se han derivado abundancias químicas para la muestra, usando ya sea una estimación directa de la temperatura electrónica o calibraciones empíricas. Se comparan los resultados para abundancias obtenidos utilizando diferentes calibraciones empíricas. Los resultados preliminares para estas galaxias muestran que las abundancias siguen una correlación con las luminosidades azul y cercana infrarroja, masa total H I y el color.

ABSTRACT

A spectrophotometric study of a sample of dwarf H II galaxies located in the Virgo Cluster has been performed. Long-slit optical spectroscopy has been obtained for 25 blue dwarf galaxies selected across the Virgo central field with the aim of understanding the role played by the environment in the evolution of dwarf galaxies. This sample is a subset of a larger list of dwarf galaxies for which deep Hα imaging has been collected. Chemical abundances have been derived for the sample using either a direct estimation of the electron temperature or empirical calibrations. Abundances obtained using different empirical calibrations have been compared. Preliminary results show abundances to be correlated with blue and near-infrared luminosity, total H I mass and color, with lower abundances associated with the fainter, gas-rich, bluer galaxies.

Key Words: **GALAXIES: ABUNDANCES — H II REGIONS**

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1. INTRODUCTION

Within the study of the galaxy evolution it is now well established that the environment plays a significant role. On theoretical grounds, it would be expected that galaxies located in high-density regions such as clusters of galaxies may suffer the effects of interactions, giving rise to a certain degree of mass loss and/or redistribution; also, due to the interaction with the (hot) intracluster medium (ICM), the gaseous component of galaxies may be affected by ram pressure stripping and/or evaporation. The relatively high density of the ICM together with the higher probability of encounters in rich clusters may produce selective loss of gaseous galactic material. The existence of a morphology-density relation in clusters is in line with the observed deficit of gas-rich dwarf galaxies in dense environments.

A direct environmental impact on the activity of star formation in galaxies is expected to be observed (e.g., Hashimoto et al. 1999; Iglesias-Páramo & Vílchez 1999), which is of particular relevance for the issue of galaxy evolution, owing to the strong implications that gas flows (in/outflows), gas stripping, and/or pressure confinement may have for the study of the chemical evolution of galaxies. Available observational results show a significant deficiency in observable H I content Virgo compared with field spirals. However, other results obtained for the molecular component show that cold molecular clouds located near the center of these galaxies, which accumulate large amounts of H_2 and CO, do not appear to disintegrate into the ICM (Kenney & Young 1988; Boselli et al. 1997). Since gas-rich dwarf galaxies are really fragile systems, it is expected that the impact of the environment will be significant. The analysis of the spectroscopic properties of samples of dwarf galaxies selected from the local supercluster foreground, several nearby voids, and from the Virgo cluster seems to show that galaxies in low-density regions present higher star formation rates and excitations (Vílchez 1995). An investigation has been undertaken in order to study the prime importance that environmental effects in dwarf galaxies have for the understanding of their chemical evolution, the metal enrichment of the ICM, and the origin of the observed metallicity-luminosity relation.

There is no systematic spectroscopic study in the literature of an extended sample of Blue Compact Dwarf (BCD) galaxies in the Virgo Cluster, with

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the exception of several dwarf galaxies studied with low-resolution spectroscopy in pioneering studies by Gallagher & Hunter (1989) and Izotov & Guseva (1989). The location in Virgo has the bonus of being relatively nearby, therefore allowing all star forming complexes to be spatially resolved. In addition, since all the objects are at the same approximate distance, the uncertainties in the analysis introduced by errors in the distance will be minimized. In this paper we report on the first stage of the project and present some preliminary results. Further details on this research will be published in a forthcoming paper (Vílchez & Iglesias-Páramo 2002, in preparation).

2. OBSERVATIONS AND RESULTS

Within an ongoing project intended to obtain deep Hα imaging for all the BCD and Irregular galaxies in the VCC catalogue (Binggeli, Sandage, & Tammann 1985), a sample of 25 VCC objects classified as blue dwarf galaxies (23 Virgo plus 2 background) was selected for our spectroscopic study, covering the VCC morphological classes: BCD, Im or Im/BCD (pec). Long-slit spectra were obtained using the ISIS spectrograph at the Cassegrain focus of the WHT 4.2-m telescope, for the spectral ranges $\lambda\lambda\,3400$–$7400\,\text{Å}$ (plus $\lambda\lambda\,8000$–$9700\,\text{Å}$ for a few selected objects of the sample). The effective spectral resolution was 2 Å at 0.33 arcsec/pixel spatial sampling along the slit. All galaxies were selected from the Virgo central field ($\pm5°$ from M 87) for which the Hα survey is being carried out. Data reduction followed standard procedures and all the spectra were flux-calibrated.

For all the spectra, a self-consistent procedure was applied in order to fit simultaneously the reddening coefficient, $C(\mathrm{H}\beta)$, and the observed equivalent width in absorption of the Balmer lines, EW(Hn). In this procedure, EW(Hn) was approximated to be constant for all the Balmer lines observed.

Measurements of the flux in the [O III] $\lambda\,4363\,\text{Å}$ line were obtained for 8 objects of the sample, for which a direct determination of the abundance was performed. For the rest of the objects, abundances were derived from empirical calibrations using: R_{23} (Pagel et al. 1979, as parametrized by McGaugh 1991); S_{23} (Vílchez & Esteban 1996, as calibrated by Díaz & Pérez-Montero 2000); and N/O (Dopita et al. 2000). The [N II]/[O II] ratio was used to discriminate between the upper/lower calibration branch, in combination with the derived upper limits to the flux of the [O III] $\lambda\,4363\,\text{Å}$ line. Oxygen abundances and N/O abundance ratios were derived for 23 Virgo dwarfs plus 2 likely background galaxies. Preliminary results obtained for the sample galaxies provide oxygen abundances in the range $Z_{\odot}/25 \leq Z \leq Z_{\odot}$ whereas their corresponding nitrogen-to-oxygen ratios range from values typical of field, low metallicity BCD galaxies up to solar values.

The abundances derived appear well correlated with luminosity in the B and H bands, colors and total H I content of the galaxies. Those objects presenting the lower chemical abundances appear to be associated to the the fainter, gas-rich, and bluer galaxies of the sample. The abundance results for our sample galaxies are roughly consistent with the overall shape of the metallicity-luminosity relation (Richer et al. 1998), though a few outstanding exceptions to the general behavior have been observed which deserve further study, in particular given their higher nitrogen-to-oxygen ratios.

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