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BROAD-BAND PHOTOMETRY OF SELECTED HII GALAXIES[1]

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RESUMEN

Se han determinado magnitudes aparentes B,V,R e I para 47 galaxias HII seleccionadas de la literatura, para las cuales existen datos espectrofotométricos de alta calidad. Con estos datos, se han obtenido magnitudes absolutas e índices de color de los objetos. Las magnitudes absolutas azules derivadas están distribuidas en el intervalo entre −22 y −14, con el máximo en $M_B \sim -19$, y los índices de color tienen valores medios $\langle M_B - M_V \rangle = 0.48{\pm}0.57$, $\langle M_V - M_R \rangle = 0.33{\pm}0.51$, $\langle M_R - M_I \rangle = 0.26{\pm}0.59$. Se discute el comportamiento de una posible relación entre la Metalicidad y la Luminosidad de los objetos.

ABSTRACT

B, V, R and I apparent magnitudes have been determined for 47 HII galaxies from the literature for which high quality spectrophotometric data exist. From these data we derive absolute magnitudes and color indices. The measured absolute magnitudes, M_B, are in the range from −22 to −14 with a maximum around −19 and the mean color indices are $\langle M_B - M_V \rangle = 0.48{\pm}0.57$, $\langle M_V - M_R \rangle = 0.33{\pm}0.51$, $\langle M_R - M_I \rangle = 0.26{\pm}0.59$. The behaviour of a possible Metallicity-Luminosity relation is discussed.

Key words: **GALAXIES: PHOTOMETRY – GALAXIES: STARBURST**

1. INTRODUCTION

For the last two years we have been carrying out an observational project to obtain CCD images and broad-band magnitudes for a large sample of HII galaxies. The aim of the project is to analyze the morphology of the objects and the behaviour of their continuum emission in relation to other characteristics such as physical parameters and chemical composition of the ionized gas and the age of the starburst. In this work we present the first results. The sample analyzed includes objects from the lists by Vigroux *et al.* (1987) and Maza *et al.* (1990), for which reliable oxygen abundance determinations are available.

2. OBSERVATIONS AND DATA REDUCTION

Direct images with Johnson broad-band filters (BVRI) were obtained with the 2.1m telescope at the Observatorio Astronómico Nacional at San Pedro Mártir, in 1991. A large-format blue-coated Thompson CCD was employed. Exposure times were from 10 to 20 min for images in the B band and from 5 to 10 min for V, R and I images. Photometric standard stars from the lists by Landolt (1992) and Christian *et al.* (1985) were also observed to calibrate the data. The spatial resolution of the images is about 2". The data were reduced

[1]Based on observations collected at the Observatorio Astronómico Nacional, San Pedro Mártir, B.C., México

with the IRAF photometric package. Apparent magnitudes were measured defining circular apertures trying to include all the emission of the objects. No subtraction of the nebular emission lines was done. The final calibration of the magnitudes, which includes corrections for atmospheric extinction and second order effects of the detector, was performed with software developed by us. For the Observatorio Astronónico Nacional we have adopted the atmospheric extinction coefficients reported by Schuster (1982). The mean apparent magnitudes of the sample are $\langle B \rangle = 16.78 \pm 1.13$, $\langle V \rangle = 16.25 \pm 1.18$, $\langle R \rangle = 15.80 \pm 1.57$ and $\langle I \rangle = 15.58 \pm 1.29$.

3. RESULTS AND DISCUSSION

3.1. Absolute magnitudes and colors

Dereddened absolute magnitudes in B, V, R and I bands were computed using the expression

$$M = m + 5 \log H_0 - 5 \log[(1+z) - (1+z)^{0.5}] - A - 53.89.$$

Redshifts z were obtained from radial velocities published by Peña *et al.* (1991, hereafter PRM), corrected to the reference frame of the background radiation as given by de Vaucouleurs *et al.* (1991). When available, z was taken from the data of de Vaucouleurs *et al.* All distance dependent values were derived using $q_0 = 0.5$ and $H_0 = 75$ km/s/Mpc. The correction for galactic absorption, A, was determined for each object at each color using the galactic reddening values, $E(B-V)$, published by Burstein & Heiles (1982) and the reddening law by Whitford (1958). No corrections for internal reddening or redshift effects (K correction) were applied.

Redshifts, interstellar reddenings, blue absolute magnitudes, color indices and oxygen abundances are presented in Table 1. Uncertainties in the derived magnitudes have been estimated considering the uncertainties in apparent magnitude and radial velocity determinations and are less than 0.5 mag for most of the cases. The uncertainties could be larger for the nearest objects ($z \leq 0.005$) for which the effect of a peculiar velocity, relative to the Hubble flow, could be significant. Oxygen abundances presented in this table were taken from PRM or recalculated from reliable spectrophotometric data given by the authors marked in the last column.

We have found that the studied sample presents a wide range of absolute magnitudes, from very bright objects with $M_B \sim -22$ to faint ones with $M_B \sim -14$, although 76% of the objects have magnitudes between -16 and -20, with an almost flat distribution. The mean dereddened colors for these objects are $\langle M_B - M_V \rangle = 0.48 \pm 0.57$, $\langle M_V - M_R \rangle = 0.33 \pm 0.51$, and $\langle M_R - M_I \rangle = 0.26 \pm 0.59$. Compared with elliptical and spiral galaxies, HII galaxies in this sample show bluer colors, similar to F0 or earlier main sequence stars. This is a consequence of the violent starburst which is dominating the optical continuum. This result is similar to that reported by Moles *et al.* (1987) for a sample of narrow emission line Zwicky galaxies. Compared with the emission line galaxies of the UM Survey (Salzer *et al.* 1989, hereafter SMB), our objects show a slightly bluer mean value for $B - V$.

3.2. Metallicity-Luminosity relation

In Figure 1 we present the behaviour of metallicity (represented by the oxygen abundance tabulated in Table 1) as a function of blue absolute magnitude for the sample. It is evident that, although these objects show a wide range of luminosities, their metallicities are in a narrow range, from $12 + \log O/H = 7.6$ to $12 + \log O/H \leq 8.5$. There are no high metallicity objects and only 3 of them show $12 + \log O/H \leq 7.6$. A very similar behaviour can be found in the other photometric bands. Bright emission line galaxies with $12 + \log O/H > 8.5$ have been reported by SMB, but those objects turned out to be nuclear starburst galaxies and belong to a different morphological category than the objects in the present sample.

No evident relation is observable between metallicity and absolute luminosity. The brightest objects ($M_B \leq -20$) show a metallicity similar to the average value and we do not find bright HII galaxies with very high or very low O/H. This absence cannot be attributed to selection effects because such objects must be easily detected in spectroscopic or photometric surveys. Therefore, very low-metallicity bright galaxies must be nonexistent or very rare. On the other hand, in Figure 1 there is a trend to find the few low-metallicity objects among the faintest ones and we do not find very high-metallicity faint galaxies. The lack of these last objects, however, could be due to selection effects; these galaxies would be intrinsically faint and would have faint emission lines, consequently their detection is not easy. In Figure 1, the broken line shows the Metallicity - Luminosity relationship found by Skillman *et al.* (1989) for a sample of nearby irregular and dwarf elliptical galaxies. Similar relations have been also reported for normal ellipticals and spirals (eg., Lequeux *et al.* 1979) and for the SMB sample.

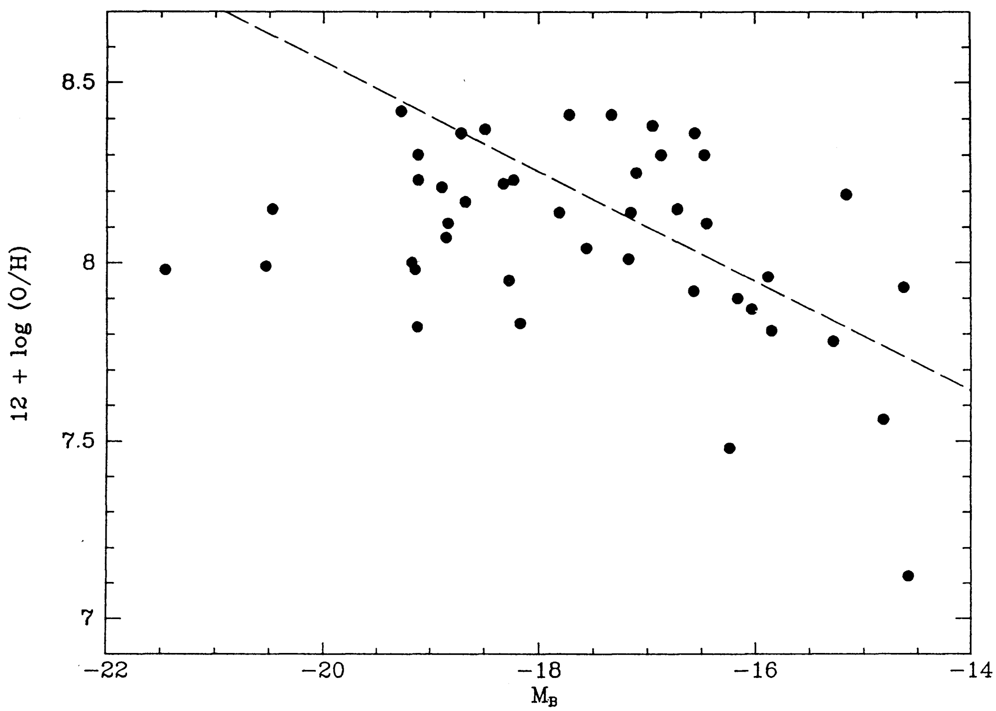

Fig. 1. — Metallicity vs. Blue absolute magnitude.

Relative to the Skillman *et al.* relation many of our objects show brighter luminosities at a given O/H. This is to be expected due to the violent ongoing starburst. Once the young hot stars evolve, these galaxies will move toward lower luminosities approaching the broken line. However, an important fraction of the sample show lower luminosities than the relation and, as the starburst evolves, these objects will move away from the line destroying the relation. More and more reliable observations are needed to elucidate this important matter.

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