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THE COLOURS OF H II GALAXIES

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RESUMEN

Resumimos los resultados de nuestro estudio de fotometría superficial de alta resolución, en el filtros V, R e I, de 15 galaxias H II a partir de los telescopicos NOT (Nordic Optical Telescope) y JKT (Jacobus Kapteyn Telescope) situados en las Islas Canarias. Los colores del contínuo del "starburst" y de la galaxia subyacente fueron medidos. La distribución de colores en la galaxia subyacente en galaxias H II es similar a la distribución de colores de galaxias con bajo brillo superficial sugiriendo una relación cercana de estas con las fases estacionarias de las galaxias H II. Sin embargo, la comparación con modelos de síntesis de población estelar reciente, muestra que los errores observacionales y las incertezas en los modelos son aún muy grandes como para permitir poner límites estrictos a la historia de la formación estelar.

ABSTRACT

We summarize the results of our high spatial resolution CCD surface photometry study in the optical V, R, and I filters of 15 H II galaxies from the Nordic Optical Telescope and the Jacobus Kapteyn Telescope at Canary Islands (Telles & Terlevich 1996). The colours of the starburst continuum and of the underlying galaxy are measured. The distribution of colours of the underlying galaxy in H II galaxies is similar to the colours of other late type low surface brightness galaxies which suggests a close kinship of these with the quiescent phases of H II galaxies. However, comparison with recent evolutionary population synthesis models show that the observational errors and the uncertainties in the models are still too large to put strict constraints on their past star formation history.

Key words: **GALAXIES: COMPACT — GALAXIES: IRREGULAR — H II REGIONS**

1. INTRODUCTION

H II galaxies are dwarf galaxies undergoing violent star formation. These low redshift objects have low heavy element abundances and high rates of star formation. H II galaxies populate low density environments and are isolated from giant galaxies (Telles & Terlevich 1995). The very cause of the triggering of the present starburst is still unknown (see also the review by Brinks in this volume). The question of whether H II galaxies are primordial galaxies experiencing their very first burst of star formation or if an older stellar population from an earlier event of star formation is present has not, since it was first posed by Sargent & Searle (1970), been answered.

A full presentation of the data analysis of our surface photometry through V, R, I broad band is given in Telles & Terlevich (1996). We have inferred some properties of the star formation history in H II galaxies by comparing the observed colours (corrected for the nebular emission line contribution) with those predicted by evolutionary synthesis models and with the observed colours of samples of dwarf galaxies.

2. COMPARISON OF THE COLOURS OF THE UNDERLYING GALAXIES WITH OTHER DWARF GALAXIES

Figure 1 shows the result of the comparison of the $V - I$ colours of the *extensions* of H II galaxies (the underlying galaxy) with the total colours of different samples of dwarf galaxies. The underlying galaxy in H II galaxies is best compared with late type low surface brightness (LSB) galaxies (top panels) as opposed to early

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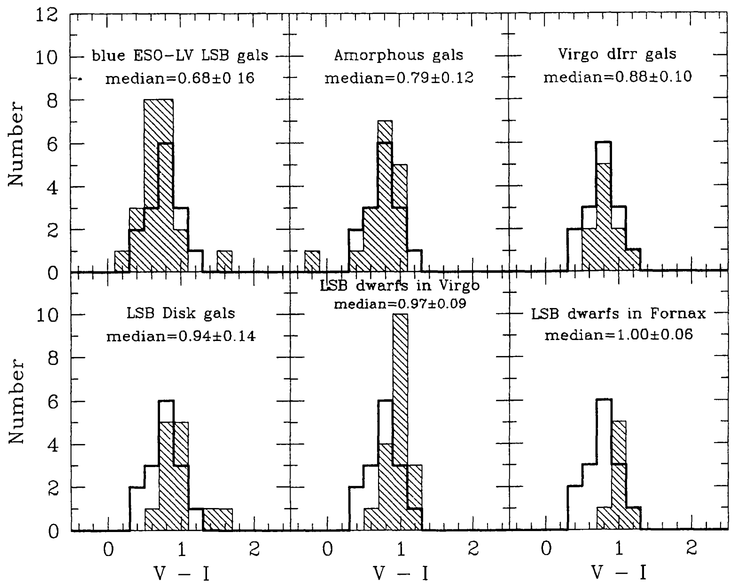

Fig. 1. Comparison of the colours of the *extensions* of H II galaxies (solid line histograms) control samples of dwarf galaxies (hatched histograms): Blue ESO-LV LSB galaxies (Rönnback & Bergvall 1994); Amorphous galaxies (Gallagher & Hunther 1987); Virgo dIrr galaxies (Bothun et al. 1996); LSB disk galaxies (McGaugh & Bothun 1994); LSB dwarf ellipticals in Virgo (Impey et al. 1988); LSB dwarf ellipticals in Fornax (Bothun et al. 1991). For H II galaxy these values are $V - I = 0.74 \pm 0.14$ and $R - I = 0.51 \pm 0.18$.

type dwarfs (e.g., LSB dwarfs ellipticals in Virgo or Fornax). The remarkably blue colours of the underlying galaxy may indicate the lack of an old diffuse red disk such as in high surface brightness spiral galaxies or extremely low metallicty. Blue LSB galaxies may be quiescent counterparts of H II galaxies in the process of accumulating fuel for the intermittent burst of star formation, until eventual gas depletion. In Telles (1995), I also found that "aged" H II galaxies and dwarf ellipticals fall approximately in the same locus in the Luminosity - Surface Brightness diagram and in the size - velocity dispersion diagram. Although the results for the small sample of H II galaxies do not allow us to discuss in detail, the trends are suggestive that a possible evolutionary scenario for dwarf galaxies is not ruled out.

3. COMPARISON OF H II GALAXY COLOURS WITH EVOLUTIONARY POPULATION MODELS

3.1. The Age of the Starburt

Figure 2*a* shows the observed colours of the starburst (filled circles). The colours of the starburst are either redder in $V - R$ or bluer in $V - I$ than the model predictions, even after the emission line subtraction. Also, the colours of the starbursts are still too red as compared to what one expects for a very young single stellar burst ($\approx 10^7$ yrs). Various sources of uncertainties may be the causes of the discrepancies. Some of them are: (i) reddening; (ii) the contribution of the underlying galaxy; (iii) the emission line correction; (iv) uncertainties in the models themselves.

3.2. The Age of the Underlying Galaxy

Figure 2*b* shows the colour-colour diagram for the extensions beyond the ionized region (ext). The position of the galaxy colours in this diagram seems to suggest that the underlying galaxy in H II galaxies have ages ranging from a few 10^9 to 10^{10} years when compared with the SSP models at low metallicity ($Z = 1/20\ Z_\odot$). This brief stellar population analysis is consistent with the findings of the comparison with the colours of other dwarf galaxies and seems to rule out the young galaxy hypothesis for these systems.

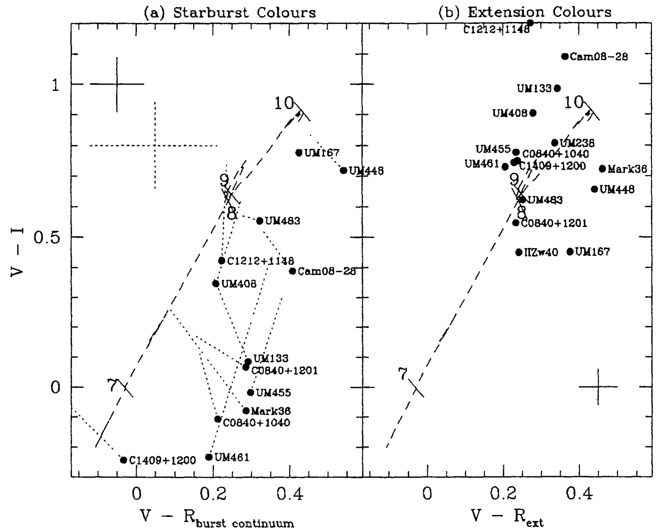

Fig. 2. Dereddened colour-colour diagrams. a) Colours of the starburst region alone. The dotted lines drawn from each point illustrate the effect on these colours when the emission line contribution is subtracted. b) Colours of the extensions. The dashed lines are the stellar evolutionary model from (Bressan et al. 1991) for Z = 0.001. Ticks are labeled in log(age).

4. SUMMARY

(i) In Telles, Melnick, & Terlevich (1996), we have devised a broad morphological classification scheme. H II galaxies may be described as two different classes of objects: Type I H II galaxies ($M_V < -18.5$) are more luminous and show disturbed morphology; Type II H II galaxies ($M_V > -18.5$) are compact and regular. They show no signs of being products of interactions or mergers.

(ii) Late type LSB galaxies may be good candidates for being the progenitors of H II galaxies.

(iii) Evolutionary models fail to fit quantitatively the observed colours of the starburst in H II galaxies, particularly at these low metallicities.

(iv) If the models are right to predict the colours of the intermediate and old stellar population, then the colours of the underlying galaxy in H II galaxies are not compatible with them being truly young galaxies having their very first burst of star formation. A blue underlying galaxy of intermediate age is detected.

REFERENCES

Bothun, G. D., Mould, J. R., Caldwell, N., & Macgillivray, H. T. 1986, AJ, 92, 1007
Bothun, G. D., Impey, C.D., & Malin, D. F. 1991, ApJ, 376, 404
Bressan, A., Chiosi, C. & Fagotto, F. 1994, ApJ, 94, 63
Gallagher, J. S., & Hunter, D. A. 1987, AJ, 94, 43
Impey, C., Bothun, G., & Malin, D. 1988, ApJ, 330, 634
McGaugh, S. S., & Bothun, G. D. 1994, AJ, 107, 530
Rönnback, J., & Bergvall, N. 1994, A&AS, 108, 193
Sargent, W. L. W., & Searle, L. 1970, ApJ, 162, L155
Telles, E. 1995, The Structure and Environment of H II Galaxies, Ph.D. thesis, Univ. of Cambridge
Telles, E. & Terlevich, R. 1995, MNRAS, 275, 1
________________. 1996, MNRAS, submitted
Telles, E., Melnick, J., & Terlevich, R. 1996, MNRAS, submitted