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H II REGIONS IN RING GALAXIES

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RESUMEN

Tomamos imágenes de una muestra de nueve galaxias anilladas en las líneas de Hα+[N II] con la intención de mapear la distribución de regiones H II en ellas. Las regiones H II fueron detectadas en todas las galaxias observadas, con la mayoría de estas regiones confinadas al anillo. Detectamos emisión en Hα, aunque débil, en la parte interna del anillo en cuatro galaxias. Esta emisión es 20–30% de la emisión total en tres galaxias (Arp 141, 291, y 143) y 45% en NGC 2793. Se discute la utilidad de observar estas galaxias con emisión interna del anillo para determinar gradientes de metalicidad.

ABSTRACT

We carried out Hα+[N II] emission line imaging survey of a sample of nine ring galaxies in order to map the distribution of H II regions in them. H II regions are detected in all the nine galaxies, with a majority of the H II regions confined to the ring. In four of the sample galaxies, we detect relatively faint intra-ring Hα emission. The intra-ring/total flux fraction is 0.20–0.30 in three cases (Arp 141, 291, and 143) and 0.45 in the fourth (NGC 2793). The utility of these galaxies with intra-ring Hα emission for the determination of abundance gradients is discussed.

Key Words: **GALAXIES: ABUNDANCES — GALAXIES: INTERACTIONS — GALAXIES: PHOTOMETRY**

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1. MOTIVATION

Ring galaxies are believed to have formed as a result of on-axis collisions between an intruder galaxy and a gas-rich disk galaxy. Such a collision sets off a radially expanding stellar density wave in the disk of the gas-rich galaxy (Lynds & Toomre 1976). Compression of the gas by the density wave is expected to trigger star formation in ring galaxies. As the density wave moves outwards, the zone of star formation is also expected to progressively move outwards, with the ring marking the zone of current star formation activity or, equivalently, H II regions. In the handful of galaxies for which information on the distribution of H II regions is available, the H II regions are found to be exclusively concentrated in the ring (Marston & Appleton 1995; Higdon 1996), thus supporting the basic picture of the formation of ring galaxies. Kinematical age of rings are typically a few hundred million years (Appleton & Struck-Marcell 1996).

Spatial segregation of stellar populations of different ages in ring galaxies makes them excellent laboratories to test the chemical evolutionary models of galaxies, as explained below. The first-formed high- and intermediate-mass stars, now located close to the central part of the ring, have had enough time to disperse the products of their nuclear synthesis, while the metals are still being synthesized in the massive stars in the ring. Simple chemical evolutionary models predict the enrichment of not only oxygen, but also nitrogen with respect to oxygen, in the central regions as compared to the values at the ring. These predictions can be tested, provided there are H II regions at different radial distances from the center to measure the abundance gradients in these galaxies. We carried out deep Hα imaging observations with the aim of detecting H II regions spanning different radial zones of a ring galaxy. In this contribution, we summarize the results of the Hα imaging of nine galaxies. The results of abundance analysis of the newly-detected H II regions will be reported elsewhere.

2. OBSERVATIONS AND RESULTS

Ring galaxies in the northern sky from a sample of Appleton & Struck-Marcell (1987) were imaged using redshifted Hα filters at the 2.1-m telescope at the Guillermo Haro Astrophysical Observatory, Cananea, Mexico. In total, nine galaxies were observed during February 2–6, 2000. Hα filters were of 100Å width and hence include both the nitrogen lines flanking Hα. Observations were carried out in the R-band also, which were used to obtain continuum-free Hα+[N II] images. The limiting Hα+[N II] surface brightness of the images is around 0.5×10^{-16} erg s^{-1} cm^{-2} arcsec^{-2}.

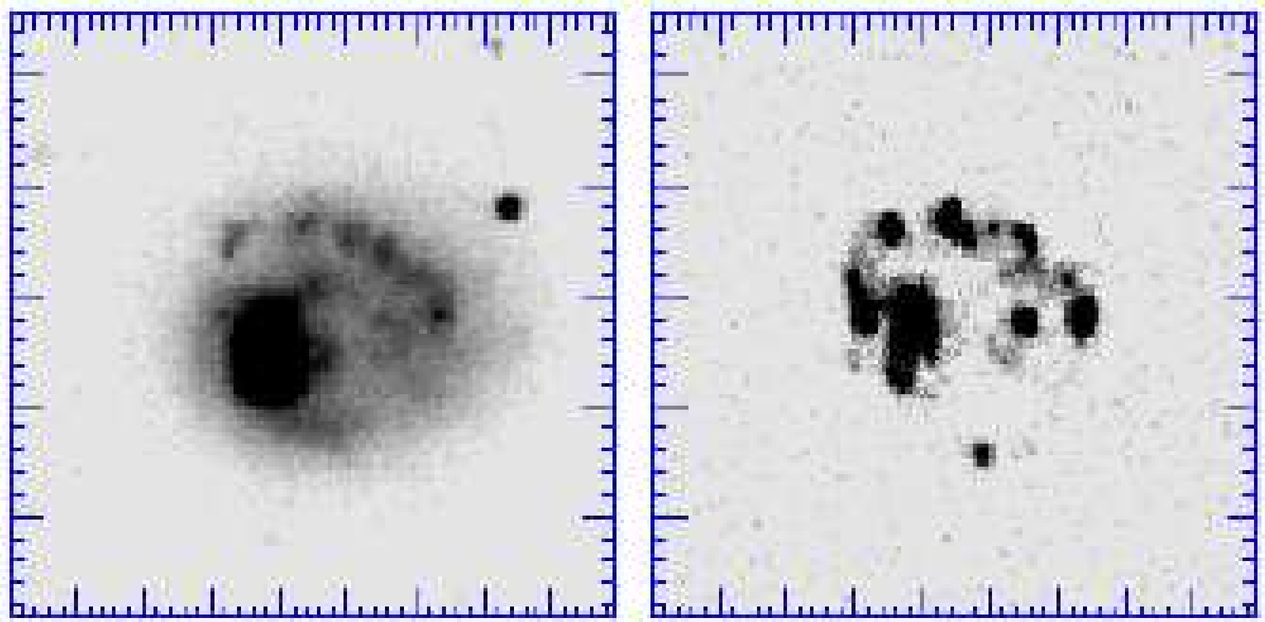

Fig. 1. Grey-scale images in R (left) and Hα+[N II] bands (right) of the ring galaxy NGC 2793. The R-band traces the distribution of old stars while the Hα+[N II] image traces the population of H II regions and diffuse ionized gas. The outermost H II regions delineate the ring. Note that there is considerable emission interior to the ring.

H II regions were detected in all the nine galaxies, with the ring being traced better in the Hα image than the R-band image. In five of the galaxies, the H II regions are exclusively concentrated to the ring. In the remaining four, we detected H II regions and diffuse ionized gas interior to the ring. These galaxies are Arp 141, Arp 143, Arp 291, and NGC 2793. The Hα+[N II] emission interior to the ring lies in the range 20–30% of the total in the first three, while in NGC 2793 it is as much as 45%. An Hα+[N II] image of NGC 2793 is presented in Figure 1. Hence we have identified four ring galaxies, where for the first time abundance gradients of oxygen and nitrogen lines can be determined.

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