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MASSIVE STARS IN NGC 604: AN HST/NICMOS+ACS PERSPECTIVE

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RESUMEN

Se presenta el informe en avance de un análisis profundo de la región H II extragaláctica de NGC 604 en M33. Este objeto es considerado el prototipo de una asociación OB a gran escala, y sus propiedades generales (contenido de estrellas masivas, juventud y baja extinción hacia ella) hacen a este objeto ideal para un análisis detallado. En este informe presentamos los resultados preliminares de las nuevas observaciones obtenidas con la Cámara 2 de NICMOS y la Cámara Avanzada para Sondeos (ACS) del Telescopio Espacial Hubble, entre los cuales destacamos los descubrimientos de: (a) cuatro candidatas a estrellas supergigantes rojas y que se hallan asociadas espacialmente a estrellas de tipo Wolf-Rayet ya conocidas en el área; (b) una gran población de objetos estelares jóvenes que se hallan asociados a los núcleos de gas molecular previamente conocidos y a regiones de muy alta extinción, siendo algunos de estos objetos jóvenes muy luminosos.

ABSTRACT

This is a report in advance of an in-depth analysis of the extragalactic giant H II region NGC 604 in M33. This object is the prototypical scale OB association and its properties (massive stellar content, young, and low foreground extinction) make it an ideal object to a detailed analysis. Here, we present the very early results of new Hubble Space Telescope observations obtained with the NICMOS Camera 2 and the Advanced Camera for Surveys (ACS), namely: (a) the discovery of four new red supergiant star candidates which are closely (parsec-scale) associated to known Wolf-Rayet stars; (b) the discovery of a large population of young stellar objects associated to the previously known molecular cores and regions with high extinction, some of them being high luminosity objects.

Key Words: H II regions: individual (NGC 604) — open clusters and associations — stars: early-type — stars: supergiants

1. OVERVIEW OF THE PROJECT

Giant H II regions (GHRs) are among the most luminous objects that can be observed in distant galaxies. They are closely related to the starburst phenomenon, where the star formation occurs at extremely high rates. Their natural extension to larger scales are the starburst galaxies, which can be traced to cosmological distances and used as astrophysical signposts of the star formation history of the Universe.

The morphology of the GHRs changes quite rapidly during the first few million years, significantly after the first massive star generation is born. Impressive resolved examples showing these evolutionary morphologies in GHRs are given by Maíz Apellániz (2000) and MacKenty et al. (2000) for the case of the irregular galaxy NGC 4214.

We must study the nearby resolved examples of GHRs in order to improve our knowledge of the properties of these objects in the distant Universe, but GHRs are not very common in the Local Group neighbourhood. Two prominent objects in the Local Group are 30 Doradus in the LMC and NGC 604 in M33. These two GHRs present different morphologic characteristics, being 30 Dor the prototype of super star cluster (SSC) with a defined cluster core, and NGC 604 a GHR composed by large OB associations without a defined core, known as scaled OB association (SOBA, see Maíz Apellániz 2001).

The main goal of this project is to perform the most comprehensive multi-frequency study of NGC 604, in order to get the most complete and detailed picture of a SOBA. To accomplish such an en-

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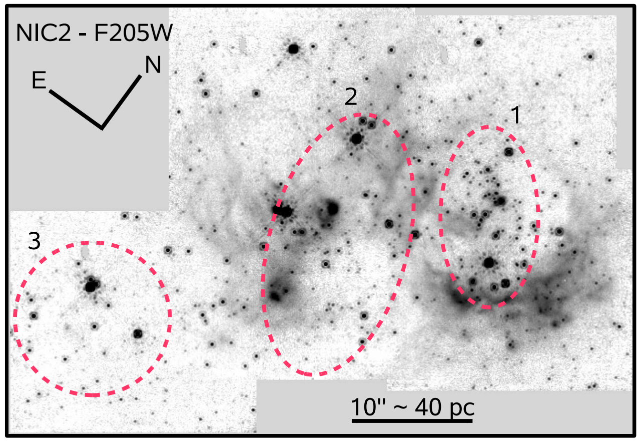

Fig. 1. NIC2 mosaic obtained through filter F205W (similar to K-band) of NGC 604. Ellipses labeled with "1" and "2" mark the position of the main and secondary SOBAs (for details see Maíz Apellániz et al. 2004), the circle labeled "3" is a new OB association to the South.

terprise, we plan to classify spectroscopically about 200 massive stars, to measure their spectral energy distribution from 1300 Å to 2.2 μm, to identify the younger stellar population (mostly hidden inside dust clouds), to determine the extinction law and the possible variations as a function of environmental conditions, and to analyze the relationship between the hot stars and the surrounding gas and molecular clouds. The project is based mostly on observations gathered using Hubble Space Telescope instruments (WFPC2, STIS, NICMOS and ACS), near-infrared narrow-band imaging with NIRI at Gemini North, and the CO 1-0 transition observed with the Combined Array for Research in Millimeter-wave Astronomy (CARMA). The NICMOS, STIS and ACS data were obtained under proposals 10419 (PI R. Barbá), 9096 and 10722 (PI J. Maíz Apellániz), respectively.

In this first report, we present the NICMOS camera 2 (NIC2) observations of NGC 604 and a neighbour control field obtained through broadband filters F110W, F160W and F205W. These observations cover the $35'' \times 35''$ central part of NGC 604, with an additional subfield to the South, where a bright infrared source and a CO cloud are located. A "control" field with the same exposure times and dither pattern was obtained about $1'$ to the north of the core of NGC 604 in order to be used for comparison in the photometric analysis.

The NIC2 images were processed using the PyDrizzle package (Hack 2002) and registered to the ACS HRC mosaics of the same field. Figure 1 shows the complete F205W mosaic of NGC 604, indicating the main and secondary SOBA, as described by Maíz Apellániz et al. (2004), and a new OB association to the South. Point spread function (PSF) photometry was performed on the complete set of NIC2 images, using both observed and synthetic PSF stars, allowing us to reach 5σ source detections at about 22 mags in the F205W filter, corresponding to a main-sequence early-B type star at the distance of M33 (840 kpc).

From the very early analysis of NIC2 imaging and the comparison with ACS and NIRI data we can highlight the following discoveries: (a) four new red supergiant star candidates and their spatial association (at $1''$ scale, i.e. 4 pc) with known WR stars or WR candidates; and (b) a large population of young stellar objects associated to the previously known molecular cores and filled H II regions, some of them being high luminous objects (about $10^5\ L_\odot$).

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