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# GTC LONG-SLIT SPECTROSCOPY OF COMPACT STELLAR CLUSTERS IN M81

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RESUMEN

En este trabajo presentamos edades de 4 cúmulos estelares compactos de la galaxia cercana M81. Las edades fueron determinadas usando los espectros de rendija larga obtenidos con el Gran Telescopio Canarias (GTC). Obtuvimos edades entre 5–6 Myr para los 4 cúmulos, incluyendo para el cúmulo más brillante de M81. Uno de los cúmulos muestra características espectrales de las estrellas Wolf-Rayet. Las edades obtenidas sugieren masas entre 3000–18000 $M_\odot$. Los objetos observados fueron los más brillantes, y por lo tanto los más masivos, de toda la galaxia. Esto implica la ausencia de cúmulos compactos masivos ($10^5$ $M_\odot$) en M81.

ABSTRACT

We here present the ages of four compact stellar clusters (CSCs) in the nearby spiral galaxy M81, using long-slit optical spectra obtained with the 10.4 m Gran Telescopio Canarias (GTC). All the four CSCs, including the brightest in this galaxy, are found to have ages between 5–6 Myr, with one of them showing Wolf-Rayet spectral features. The photometric masses of these clusters, calculated using their spectroscopically-derived ages, lie between 3000–18000 $M_\odot$. The observed clusters are among the brightest objects, and hence the most massive, in the entire disk of M81. This implies the absence of massive ($10^5$ $M_\odot$) compact stellar clusters in M81.

*Key Words:* galaxies: individual (M81) — galaxies: star clusters

## 1. INTRODUCTION AND OBSERVATIONS

The similarity in the ranges of sizes and masses of the compact star clusters (CSC) and the globular clusters (GCs) has given rise to the notion of an evolutionary connection between them (de Grijs & Parmentier 2007). The vast difference in the ages of the two populations, and the absence of any prototypical cluster of age intermediate between these two extreme cases, has prevented progress in exploring further this idea. Crucial for understanding the evolutionary connection between these two populations is the identification of compact clusters of intermediate ages ($\sim 10^8$ yr). Spectroscopic observations are vital to ascertain ages in these age ranges.

The nearby galaxy M81 offers a great opportunity to address the evolutionary connection, as this galaxy contains both the CSCs and GCs in large numbers (Chandar et al. 2001; Santiago-Cortes et al. 2010). Santiago-Cortes et al. (2010), using 29 HST/ACS fields cataloged 263 CSCs brighter than $B = 22$ mag, and 172 GCs. The photometric masses of the CSCs were found to be less than $2 \times 10^4$ $M_\odot$, assuming that the brightest clusters are younger than 10 Myr. According to a recent study by Bastian (2008), the highest cluster mass in a galaxy depends on its star formation rate (SFR). The expected highest mass of the cluster for the observed SFR of 1 $M_\odot$ yr$^{-1}$ in M81 is around a factor of 5 greater than that inferred. On the other hand, if the brightest clusters are older than 100 Myr, observationally inferred maximum cluster mass would follow the relation suggested by Bastian (2008). We hence carried out spectroscopic observations of the brightest clusters with the goal of determining their ages, and therein, determine their masses.

## 2. OBSERVATIONS AND DATA REDUCTIONS

Spectroscopic observations were carried out using the long-slit of the spectrograph of the OSIRIS instrument at the 10.4 m GTC[2] in the service mode on 2010 April 4 and 5. Six slit positions were used to obtain spectra of 13 clusters brighter than $B = 21$ mag (11 CSCs, including the brightest CSC, and 2 GCs), and a few fainter CSCs. Spectra cover a range of 3630 to 7500 Å, at a spectral resolution of $\sim$7 Å. A slit-width of 1.0 arcsec was used. The estimated seeing during these observations is $\sim$1 arcsec.

The data reduction was carried out in the standard manner using the tasks available in the IRAF

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[2]Gran Telescopio Canarias is a Spanish initiative with the participation of Mexico and the US University of Florida, and is installed at the Roque de los Muchachos in the island of La Palma. This work is based on the proposal GTC11−10AMEX_0001.