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DEEP PHOTOMETRIC STUDIES IN THE THIRD QUADRANT: NGC 2467

R. C. Gamen,[1] R. Barbá,[1] M. Rubio,[2] R. A. Méndez,[2] and D. Minniti[3]

RESUMEN

La región de NGC 2467, ubicada en la "ventana de Puppis" del tercer cuadrante, contiene cúmulos abiertos jóvenes y estructuras nebulares reportados a diferentes distancias. Presentamos un nuevo análisis del campo de NGC 2467 basado en imágenes ópticas profundas, en los filtros *UBVRI*, obtenidas con el telescopio MPG/ESO de 2.2-m del Observatorio La Silla, Chile. Analizamos el contenido estelar y establecemos nuevas distancias a los cúmulos. Sugerimos la presencia de una población de objetos estelares jóvenes, incluyendo la detección de estructuras tipo HH. Además, descubrimos decenas de galaxias de fondo vistas a través del plano de la Via Láctea.

ABSTRACT

The region of NGC 2467, placed in the "Puppis Window" of the third quadrant, contains a number of young open clusters and nebular entities reported at different distances. We present a new analysis of the field of NGC 2467 based on deep images, in the *UBVRI* filters, obtained with the 2.2-m MPG/ESO telescope at La Silla Observatory, Chile. We analyze the stellar content and establish new distances to the clusters. We suggest the presence of a population of young stellar objects, including the detection of HH-like features. Also, we discover tens of background galaxies seen through the galactic plane.

Key Words: **GALAXY: STRUCTURE — OPEN CLUSTERS AND ASSOCIATIONS: INDIVIDUAL: HAFFNER 18, HAFFNER 19, NGC 2467**

1. MOTIVATION

NGC 2467 is located in an area of special interest in the third quadrant of the Milky Way known as "Puppis Window", which is characterized by low interstellar extinction, and therefore important to detect spiral tracers at large distances (15 kpc arm problem) and the tidal structures associated to "Argo" and "Canis Majoris" streams. The region is also interesting because it contains a number of young open clusters and nebular entities. The most conspicuous structure in NGC 2467 is the H II region S 311, excited by the peculiar O6Vnne type star HD 64315. Haffner (1957) identified the clusters 18a, 18b, 18c, and 19 (using $9° \times 11°$ plates), Haffner 18abc (Haf18) actually is an elongated open cluster with an O7 V type star as the massive component, and Haffner 19 (Haf19) is a compact cluster showing a Strömgrem sphere ionized by a B0 V type star. In the field, there are also some early-type stars as HD 64568 (O3 V ((f*))), CD -26 5129 (O7), and CD -26 5126 (B0.5 V), whose relationship with the clusters is still unknown. Earlier studies have derived very different distances to the structures in the area, including the possibility that they are not related each other (e.g. Feinstein & Vázquez, 1989; Munari & Carraro, 1996; Munari et al, 1998).

Aiming to resolve the quoted problems, we observed NGC 2467 with the WFI camera attached to the MPG/ESO 2.2-m telescope at La Silla Observatory, Chile. The observing run generated more than 140 Gb of raw data of a $34' \times 33'$ field (with a pixel size of $0\farcs238$) through the broad *UBVRI*, and narrow Hα, [SII], and [OIII] filters.

2. PRELIMINARY RESULTS

The broad band dataset comprises 155 science and 490 Landolt standards fields. The images were processed in order to remove the instrumental signatures using the MSCRED package, a mosaic specific task running within IRAF. Astrometric solutions (with rms=$0\farcs2$) were determined using the USNO A2 catalog and applied to the images. Then, each mosaic was converted into an unique large image.

We derived a photometric solution performing aperture photometry on Landolt's standard stars observed during 9 photometric nights. The color equations were solved simultaneously in *UBVRI* including colour terms. The obtained values are in good agreement with those published by the WFI team.

Images of NGC 2467 were combined to get different datasets based on their exposure times. Total

[1]Universidad de La Serena, Chile.
[2]Universidad de Chile, Santiago, Chile.
[3]Pontificia Universidad Católica, Santiago, Chile.

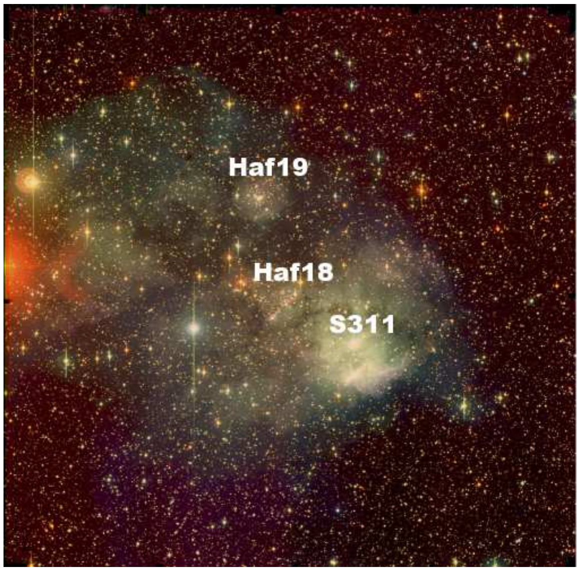

Fig. 1. The $\sim 34' \times 33'$ ESO/WFI view of the NGC 2467 region as seen after the color composition of the five broad band filters.

exposure times are 9120 sec in U, 9710 s in B, 5430 s in V, 3710 s in R, and 3640 s in I.

Instrumental magnitudes were obtained by PSF-fitting (using the DAOPHOT/ALLSTAR routine within IRAF) in the combined science frames.

Based on the 84370 detections (I band), we calculated the stellar density map in the field, and confirmed a density enhancement in the locations of Haf18 and Haf19. In the S 311 nebula, we found a drop in the stellar density, which could be explained by the presence of the dusty clouds detected in the A band (8 μm) images obtained with *MSX*.

We applied the photometric solution to our datasets, and using the stellar density map, we defined centers and radii for each cluster and constructed their color-magnitude diagrams (CMD). The distance to the clusters was derived doing a "by eye" adjustment of the MS (Schmidt-Kaler, 1982) to the data (see Fig.2), resulting 6.4 kpc, 5.9 kpc, and 6.3 kpc for Haf19, Haf18, and S 311, respectively. The mean distance derived for the three clusters locates them in the Perseus Arm, in excellent agreement with the modern spiral structure picture (Russeil 2003). Also, if we consider that the clusters Haf18 and Haf19 are related, the projected separation of $7'$ turns into only 17 pc. In this case, they are forming a binary cluster, as a younger socias of h and χ Persei clusters.

A visual inspection of science images allows us to detect tens of background galaxies of different

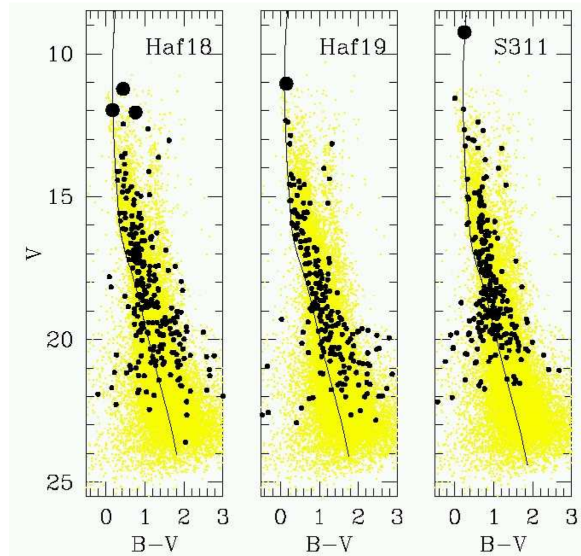

Fig. 2. CMDs of the clusters Haf18, Haf19, and S311. Larger circles represent the published photometry of the brightest stars (saturated in our images), and smaller (and lighter) ones, the all stars in the surveyed area. The curves represent the MS shifted with the fitted cluster parameters.

morphologies. This discovery confirms the "window" character of this part of the galactic plane at very low latitudes ($0.3 < b < 0.6$). This is an interesting result for further studies of these background galaxies in the Zone of Avoidance at optical wavelength. We also have found a very intriguing bi-conical nebula in the ring of dust surrounding Haf19. This nebula has a Herbig-Haro type object appearance, evidence for ongoing star forming activity in the region.

We plan further studies, i.e. zero-points of the WFI photometric system, to add new distance determinations through isochrone fitting, regarding the differential reddening, to obtain spectral types of probable members of the clusters to determine the stellar content of the aggregates and spectroscopic parallaxes.

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