Boletim da Sociedade Astronômica Brasileira, **34**, no. 1, 262-263

Searching for Conspicuous Features Around the Young Stellar Clusters NGC 3572 and NGC 3590

T. A. Sabino[1] & J. Gregorio-Hetem[1], S. Scarano Jr.[2]

[1] Universidade de São Paulo. e-mail: thay.astro@gmail.com, gregorio-hetem@usp.br
[2] Universidade Federal de Sergipe e-mail: scaranojr@academico.ufs.br

Abstract. Young stellar clusters are associated with star forming regions and have an important role in the chemical evolution of the Galaxy. However, the processes related to the star clusters formation and the interstellar medium itself remain as Astrophysical questions to be solved nowadays. Aiming to contribute to the current scenario, we perform a detailed study of the gas conditions around NGC 3572 and NGC 3590, as well the effects produced by their own stars, through SOAR/SAMI 4-band imaging. Our results have shown that the diffuse emission is detectable through the SAMI observations and the comparison between distincts band-imaging highlights the smooth structures.

Resumo. Aglomerados estelares jovens estão associados a regiões de formação estelar e desempenham um papel importante na evolução química da Galáxia. Entretanto, os processos que envolvem a formação dos aglomerados e do meio interestelar ainda permanecem como questões Astrofísicas a serem resolvidas atualmente. Visando contribuir para o cenário atual, realizamos um estudo detalhado das condições do gás em torno de NGC 3572 e NGC 3590, assim como dos efeitos produzidos pelas estrelas que os compõem, por meio de imageamentos SOAR/SAMI em 4 bandas. Nossos resultados têm mostrado que a emissão difusa é detectável pelas observações SAMI e a comparação entre imagens em bandas distintas evidencia estruturas tênues.

Keywords. ISM: general – ISM: bubbles – open clusters and associations: general – stars: formation – stars: pre-main sequence

1. Introduction

The star forming regions in the Milky Way are fundamental keys for understanding the formation and evolution of the Galactic structures and the present-day multi-band data acquisition techniques have improved the study of young stellar clusters. Stellar parameters estimated through alternative methods have been established to evaluate physical features of the interstellar medium through comparison between the light emission in distinct spectral ranges. Beyond that, the SOAR Telescope has shown to be a powerful tool in recent discoveries related to interstellar surroundings.

A detailed study of the Crab Nebula morphology comparing NIR and visible light emission is presented by Loh et al. (2010, 2011) through SOAR/Spartan and Hubble Space Telescope narrow-band imaging in H2, Brγ, [S II] and [O III] bands. More recently, Riaz et al. (2017) reported the discovery of the HH 1165, a new Herbig–Haro jet driven by a Proto-Brown Dwarf star, through SOAR narrow-band imaging in the Hα, [S II] and R bands.

Aiming to contribute to the current scenario, we performed a detailed study of the gas conditions involving NGC 3572 and NGC 3590 as well the effects produced by their own stars.

2. Methodology

We combined the softwares Aladin and StarFinder to perform the astrometrical calibration through Gaia EDR3 positions, identified stellar sources and extracted the background emission. Proper motion and parallax were used to identify cluster members and candidates (possible members).

3. Results

The diffuse emission is highlighted by removing from the image the contribution of stars. We estimate the Hα, [S II] and [O III] distributions through the SOAR/SAMI data.

In Figure 1, a higher Hα/[S II] ratio (> 5) is noticeable on the external ring of the photoevaporating globule revealing possible shock fronts. The lower Hα emission indicates that the massive stars winds are wiping the gas out more effectively.

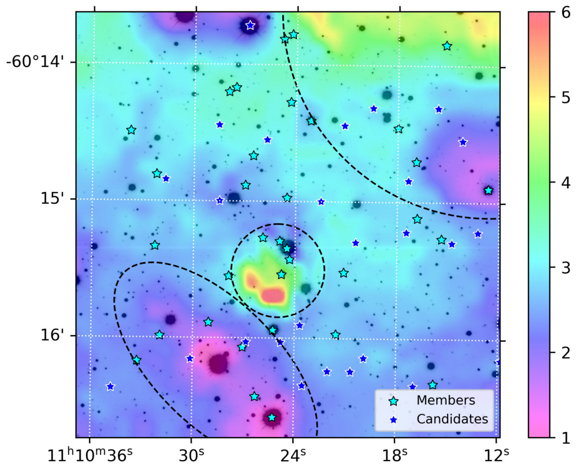

Figure 1. Hα/[S II] map for NGC 3572. The phoevaporating globule is indicated by the dashed line circle near to the center. Massive stars are mainly found in the SE region (dashed ellipse).

The [S II]/[O III] ratio reveals a major amount of low-excitation gas ([S II]/[O III] > 2) located in the photoevaporating globule at the center of the field in Figure 2. It is also evident the presence of ionized gas ([S II]/[O III] < 0.75) around the massive stars.

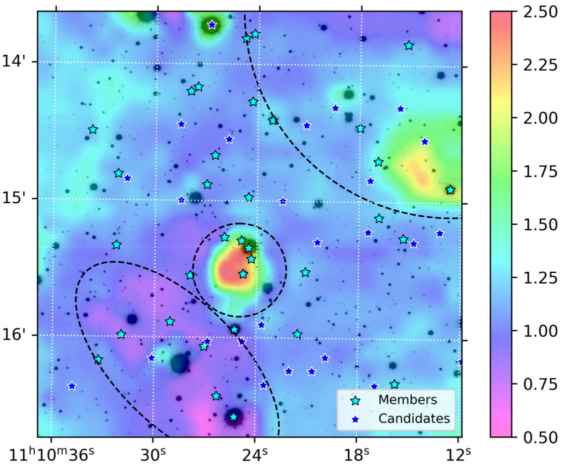

Figure 2. [S II]/[O III] map for NGC 3572.

In Figure 3, the gradient in the southern region of NGC 3590 and the central column structure (Hα/[S II] > 3) involving the northern anullus and the clusters core are remarkable and indicate the presence of excited gas, following the distribution of the diffuse emission also noticeable in infrared observations. The higher Hα emission delineates the distribution of low-velocity shocks.

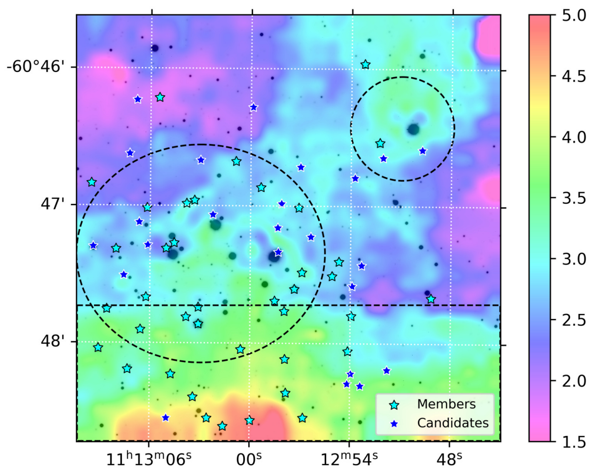

Figure 3. Hα/[S II] map for NGC 3590. Massive stars are mainly found in the central region (dashed ellipse). The northern anullus (dashed circle) delineates a conspicuous feature. The southern box highlights a tenous structure also noticeable in infrared observations.

In Figure 4, the large regions shown in purple ([S II]/[O III] < 0.35) in the cluster's core and in the northern annulus highlight the presence of ionized gas. The higher ratio shows that the major part of the low-ionization gas is located outside the cluster's border and away from the brightest stars.

Our results have shown that the interstellar medium of young stellar clusters can be detected through SOAR/SAMI and we

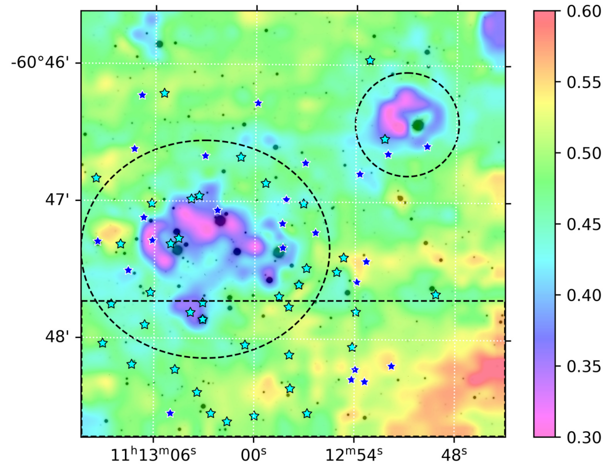

Figure 4. [S II]/[O III] map for NGC 3590.

could identify the main features of both clusters. In NGC 3572, we highlight the photoevaporating globule, for which a radial gradient of emission was revealed; the high level of ionization around the massive stars; and a small cloud to the NW. We identify 37 and 42 members and, 32 and 34 candidates in NGC 3590 and NGC 3572, respectively. The comparison of the observed color-magnitude diagrams with PARSEC isochrones (Bressan et al., 2012; Marigo et al., 2017) shows that NGC 3572 is much younger than NGC 3590, being only ~ 3 Myr old while NGC 3590 is ~ 25Myr old. Parallax distribution of the members indicates that the clusters are located at same distance approximately. We estimate a mean parallax of ~ 0.39± 0.02 mas for NGC 3590 and ~ 0.40 ± 0.02 mas for NGC 3572, which are in agreement with the literature.

Acknowledgements. We thank FAPESP (Proc. N. 2019/25062-5) for all support.

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