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Evolved massive stars in W33 and in GMC G23.3−0.3

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Abstract. We conducted infrared spectroscopic observations of bright stars in the direction of the molecular clouds W33 and GMC G23.3−0.3. We compared stellar spectro-photometric distances with parallactic distances to these regions, and we were able to assess the association of the detected massive stars with these molecular complexes. The spatial and temporal distributions of the detected stars enabled us to locate sources of ionizing radiation and to gather precise information on the star formation history of these clouds. The studied clouds present different distributions of massive stars.

Keywords. infrared: stars stars: evolution - supergiants open clusters and associations: general ISM: clouds - ISM: supernova remnants

1. Introduction

Young massive stars and stellar clusters continuously form in the Galactic disk, generate bubbles and HII regions in molecular clouds, and subsequently enrich the interstellar medium via winds and supernovae. We conducted an infrared survey for bright stars in the Galactic giant molecular clouds (GMCs) G23.3−0.3 and W33. A large number of extraordinary sub-clumps/clusters of massive stars were detected. The spatial and temporal distribution of these massive stars yielded information on the star formation history of these clouds.

2. GMC G23.3−0.3

The GMC G23.3−0.3, shown in Fig. 1, is located at the parallactic distance of 4.6 kpc (Brunthaler et al. 2009), and is remarkably rich in HII regions and supernova remnants (SNRs) (Messineo et al. 2010, 2014). We discovered a dozen massive O-type stars, one candidate luminous blue variable, and several red supergiants (RSGs). The O-type stars have masses from 25 to 50 $M_{\odot}$ and ages of a few million years, while the RSGs belong to a burst that occurred 20-30 Myr ago. GMC G23.3−0.3 has had one of the longest known

history of star formation. We detected massive stars in the cores of SNR W41 and SNR G22.7−0.2 (Fig. 1).

3. W33

The W33 complex (Fig. 1) is located on the Galactic plane at about 12.°9 of longitude and at the parallactic distance of 2.4 kpc (Immer et al. 2013). We spectroscopically detected a few evolved O-type stars and one Wolf-Rayet star, but none of the late-type objects has the luminosity of a RSG star. Several dense molecular cores that may harbor proto clusters were recently discovered on the east side of the cloud (Immer et al. 2014). We were able to identify episods of sequential star formation: evolved massive stars/clusters that are triggering these new condensations (Messineo et al. 2015). Therefore, W33 is characterized by discrete sources and has had at least 3-5 Myr of star formation, which is now propagating from west to east. The massive stellar cluster Cl1813−178 (Messineo et al. 2011) is located behind the W33 complex at a distance of about 4.8 kpc.

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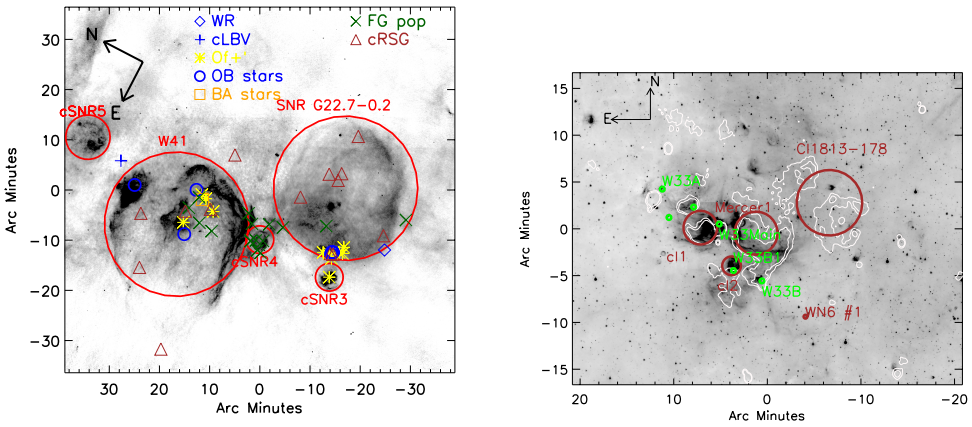

Figure 1. *Left:* 20 cm emission from MAGPIS of GMC G23.3−0.3 centred at RA 18°33′50.″96 and Dec. −08°55′34.″9. Detected massive stars are indicated (e.g., RSGs with triangles, early-type stars with diamonds, plus, and circles). SNRs are indicated with red circles. *Right:* GLIMPSE 8 um image of W33, centred at RA 18°13′51.″88 and Dec. −17°56′17.″5, with contours of 90 cm emission from MAGPIS. Prestellar cores are in green (Immer et al. 2014), while candidate stellar clusters are in red.