Observational Studies of Galactic Star-Forming Regions

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by

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Abstract

Massive stars, with their radiative, mechanical and chemical feedback, are key players influencing the local and global dynamical and chemical state of the interstellar medium through ionization and radiation pressure, stellar winds, outflows and supernovae. These stars are therefore fundamental and crucial for unravelling the astrophysics of the formation, sustenance, and dissipation of structures ranging from the largest, Galactic scales, to giant molecular clouds, disks, and planetary systems. The need for a complete and consistent picture of the processes involved in the formation of the high-mass stellar population is evident from the lack of consensus and the various theories proposed. This is compounded with the challenges in observing this regime.

Motivated by the above scenario, this thesis presents multiwavelength studies focussed towards a selected sample of Galactic massive star forming regions. With the aim to gain a better insight into the formation mechanism of massive stars and their feedback on the surrounding interstellar medium, we selected two infrared dust bubbles (S10, CS51) and two H II regions (G346.077−0.056 and G346.056−0.021). Towards north east of the bubble S10, an extended green object EGO G345.99−0.02 is located at an angular distance of $\sim 5'$, which is also studied along with S10. In addition, a statistical investigation of cold dust emission towards a large sample of seventeen IR dust bubbles has been achieved.

Low-frequency radio continuum maps are obtained using the Giant Metrewave Radio Telescope to probe the associated ionized gas. Our results provide the first low-frequency radio continuum maps of the targets under study and are a much required valuable addition to the database of high-mass stars. Radio continuum maps have helped us in exploring the associated ionized gas, the nature of the ionizing sources. In addition, exploiting the low-frequency domain where the contribution from non-thermal emission in significant, we have investigated the radiation mechanism from the generated radio spectral index maps. In case of the two H II regions studied, we attempt to shed more light on the cometary radio morphology by invoking the well known ‘bow-shock’ and ‘champagne-flow’ models.

The identification of the ionizing source and nature of the stellar population has been carried out using the available near- and mid-infrared data from various archives like the 2MASS, *Spitze*-GLIMPSE and the VVV surveys. Cold dust emission associated with these regions is investigated using far-infrared data from the *Herschel* Space Telescope archives. The generated column density probability distribution function give crucial clues to the feedback from the massive stars on the surrounding. For the bubble CS51, molecular line data from the MALT90 survey helped us in confirming the expansion of the bubble and to ascertain the evolutionary status of the cold dust clumps. These show signature of triggered star formation and the physical conditions are seen to be conducive with the 'collect and collapse' mechanism.

Studying a large sample of seventeen infrared dust bubbles yield promising results. With simplistic assumptions, the study of around hundred cold dust clumps, associated with these bubbles, lend support to the 'monolithic collapse' picture of formation. These results also impress upon the fact that bubbles are indeed ideal laboratories to explore triggered star formation.