Introduction
High-mass (M > 8 M☉) stars profoundly influence the surrounding interstellar medium (ISM). A combination of thermal pressure of the expanding HII region, powerful stellar wind, and radiation pressure associated with the newly formed massive star sculpts the ISM resulting in a ‘bubble’. Bubbles are ubiquitous in the Galactic plane and observationally manifest as shells of enhanced density of swept up gas and dust between the ionization and the shock fronts encompassing a relatively low-density, evacuated cavity around the central star. Bubbles display striking mid-infrared (MIR) morphology with 24 μm emission sampling the hot dust enclosed within bright-rimmed 8 μm emission. The MIR emission is attributed to polycyclic aromatic hydrocarbon molecules in the photodissociation regions surrounding O and early-B stars. The association with OB stars and HII regions make these ideal laboratories to probe high-mass star formation and their interaction with the surrounding medium. In this work, we present a multi-wavelength study of the southern infrared (IR) dust bubble S6. The associated ionized emission is investigated using low-frequency radio observations and physical properties of the associated dust environment is studied in far-infrared (FIR) wavelengths.

Dust Bubble S6
- Located at a distance of 2.0 kpc [1].
- Classified as a bubble showing closed ring morphology [6].
- Associated with a H2O maser and a HII jet [1].
- Likely ionized by a central ionizing star of spectral type O5V–O9V [4].
- Associated with three dense cores [1].
- Associated with a NIR star cluster [4].

 Associated Ionized Emission
- The ionized emission associated with S6 displays distinct cometary morphology at both frequencies.
- The cometary head is towards the west with a fan-like diffuse emission towards the east.
- The radio emission is more extended in the north-south direction.
- The location of radio peak is ~20 arcsec towards south-west of NIR identified ionizing star.

Emission from Dust Component
- Cold dust emission sampled in the FIR wavelengths traces the bubble morphology seen in the MIR.
- Dust clumps are seen towards the south-west of the bubble bringing more prominent as we go to longer wavelengths.
- A long, extended filamentary structure is seen towards the south-east rim of the bubble.
- The ionized gas emission extends beyond the bubble rim in the south-east direction.

References

Observations and Archival Data
- Radio continuum observations at 610 and 1280 MHz were obtained with the GMRT and data reduction was carried out using standard procedures with AIPS.
- PACS and SPIRE data in the wavelength range 70 - 500 μm was obtained from the Herschel-Space Observatory archives.
- Molecular line data were retrieved from the archives of the MALT90 survey.

Dust Temperature and Column Density Maps
- Line-of-sight average molecular hydrogen column density and the dust temperature maps are generated by pixel-wise modified blackbody fits to the 60, 170, 250, 350 and 500 μm data.

Dust Clumps
- Cold dust clumps are identified from the 250 μm image using the Fellwalker algorithm [3] with a 4σ (σ = 598 Mjy beam⁻¹) threshold.
- Three clumps (I, II and III) are identified to be associated with the cold dust emission.
- Mass of the dust clumps are estimated using the column density map and the equation:

\[ \frac{M_{\text{dust}}}{\text{pixel}} = \frac{\text{pixel}}{\text{beam}} \times N_{\text{H}_2} \times \mu \times \frac{\mu_{\text{H}_2}}{\mu_{\text{H}}} \times \text{pixel} \]  

where, \( N_{\text{H}_2} \) is the electron temperature determined using the Galactic Temperature gradient relation [2].

Kinematics of the Dust Clumps
- Of the sixteen molecular-line transitions covered in the MALTSurvey, four (N₂H⁺, HCO⁺, HCN and HNC) are detected towards Clumps I, II and III.
- N₂H⁺ molecular line spectra is used to determine the VLSR of the clumps.
- Chlor II displays double-peaked, blue-asymmetric HCO⁺ line profile with self-absorption dip coinciding with the VLSR and peak of optically thin N₂H⁺ line. This indicates infall activity.
- Derived mass infall rates are consistent with other high-mass star forming regions.

Conclusions
- Ionized emission from the region towards S6 displays cometary morphology.
- The spectral type of the ionizing star is estimated to be O7–O8.5.
- Three clumps are detected using Fellwalker algorithm.
- Using the dust temperature and column density maps, the clumps’ physical properties are determined.
- Molecular line spectra of HCO⁺ displays infall activity in clump II. The mass infall rate is calculated to be \( 9.7 \times 10^{-4} \) M⊙/yr.