Unlocking the Keyhole—H_2 and PAHs Emission from Molecular Clumps Surrounding the Keyhole Nebula

J. M. Rathborne[1], K. J. Brooks[1], M. G. Burton[11], J. W. V. Storey[1], M. C. B. Ashley[1], and R. D. Marks[1]

[1]School of Physics, University of New South Wales, Sydney, NSW 2052, Australia

The Keyhole nebula is part of the Carina Nebula, a massive star forming/molecular cloud complex. It is bathed in the UV radiation field from nearby massive stars including the spectacular star, η Carina. Optical images of the Keyhole nebula show many interesting features including dark patches and bright-rimmed globules. These bright-rimmed globules are likely to be photo-dissociation regions (PDRs). The molecular gas in the Keyhole is extremely inhomogeneous, breaking into several clumps (of $\sim$10 $M_\odot$) (Cox & Bronfman, 1995) and are all associated with the optical features described above. These clumps may be the remaining denser fragments of a molecular cloud that was destroyed by the stellar winds and ionizing flux from the nearby massive stars.

To better understand the environment surrounding these clumps we have imaged the Keyhole region at two wavelengths suitable for detecting emission coming from PDRs. The University of New South Wales InfraRed Fabry-Perot (UNSWIRF) was initially used to image H_2 1–0 S(1) (2.12 μm) emission across the Keyhole region, while the SPIREX/Abu thermal Infrared camera at the South Pole was used to image PAHs (3.29 μm) emission.

Our results reveal several interesting features. Firstly, both the H_2 and PAHs emission features are morphologically similar, existing as $\sim$9 clumps and corresponding to molecular gas clumps observed previously. Secondly, when comparing the observed emission features to optical images of the region, we find that several correspond to the bright-rimmed globules. We also find that not all dark patches in the Keyhole region which have molecular gas show H_2/PAHs emission. Finally, comparing the velocity range ($\sim$ 20 km s^{-1}) of the molecular gas obtained from $^{12}CO(2–1)$ emission (Cox & Bronfman 1995) with H_2 and PAHs emission, we find that the clumps with the most negative velocities have no H_2/PAHs emission, those with intermediate velocities correspond to the optically bright-rimmed globules and those which have the least negative velocities correspond to faint, dark patches.

Using these results we present a model for the Keyhole whereby the velocities are associated with positions along our sight line, the most negative clumps being in front of the ionization region, the bright-rimmed clumps in it, and those corresponding to dark optical clouds at the far side. We have developed a hypothesis in which these clumps, which appear to be externally heated, are being over run by the ionization region and are the last remnants of a molecular cloud. It still remains a mystery however, why these stellar mass clumps display a systematic change in velocity with position in the source.

References

Cox P., & Bronfman L. 1995, A&A, 299, 583

[1]email M.Burton@unsw.edu.au