

Infrared properties of ultracompact H II regions in the Galaxy and the LMC

Marta Sewilo¹, Ed Churchwell², Barbara Whitney¹
and the GLIMPSE and SAGE Teams

¹Space Science Institute, 4750 Walnut Street, Suite 205, Boulder, CO 80301, USA
email: sewilo@astro.wisc.edu

²University of Wisconsin - Madison, 475 N. Charter Street, Madison, WI 53706, USA

Abstract. We report the preliminary results of the study on the infrared properties of ultracompact (UC) H II regions in our Galaxy and in the Large Magellanic Cloud (LMC) based on the GLIMPSE (*the Galactic Legacy Infrared Mid-Plane Survey Extraordinaire*) and SAGE (*Surveying the Agents of a Galaxy's Evolution*) data, respectively. We found that ~60% of the Galactic UC H II regions do not have IR counterparts. Large extinction and very strong stellar winds evacuating H II regions from dust may explain this result. The same effect is observed in the LMC. One of the goals of this research is to develop a means of identifying UC H IIs based on their mid-IR properties, e.g. positions on color-color and color-magnitude plots and/or shape of spectral energy distributions. GLIMPSE showed that bow shocks, protostellar jets/outflows, and bubbles are common phenomena in massive star formation regions (MSFRs).

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High-resolution (0."6 pixel) GLIMPSE/IRAC image mosaics ($l \times b = 1.^{\circ}1 \times 0.^{\circ}8$) were used to search for the mid-IR counterparts (ionizing sources) of Galactic UC H II regions. The present sample consists of the brightest 22 UC H IIs that are not saturated in any IRAC band (3.6, 4.5, 5.8, and 8.0 μm). We found that ~60% of the radio sources do not have an IR counterpart; however, there are always IR sources in the neighborhood. Deeply embedded UC H IIs can be hidden in the IR due to local extinction and extinction along the line of sight. It is also possible that dust is evacuated from some UC H IIs by strong stellar winds, therefore there would be no IR emission observed toward these sources. A bigger sample of UC H II regions has to be examined to draw reliable conclusions. Interestingly, our preliminary analysis of the SAGE/MIPS 24 μm data for 59 UC/Compact H II regions in the LMC showed that a similar percentage of radio sources do not have IR counterparts.

We find bow shocks in the immediate vicinity of UC H II regions. The wind-wind interactions producing bow shocks are expected to be common in regions where multiple massive stars with strong winds are forming. Bipolar jets associated with protostars stand out when the 4.5 μm band is included in MIR colored images of MSFRs. This is believed to be due to shocks that excite either the H₂ line or the CO bandheads that fall within the bandpass of the 4.5 μm band. The GLIMPSE survey has also shown that the Galactic disk has a large number of dust bubbles surrounding H II regions and stellar clusters (Churchwell *et al.* 2006, ApJ, in press). The 24 μm emission is confined to the central regions of the bubbles where 8 μm emission is weak or absent. The 8 μm emission is strong in the shells and beyond, in the PDRs of the bubbles. About 7-8% of all the bubbles found in the GLIMPSE survey show a large bubble with one or more smaller bubbles projected either on the periphery of the large bubble or within its shell. This morphology suggests triggered star formation.