Study of isolated high mass star forming regions

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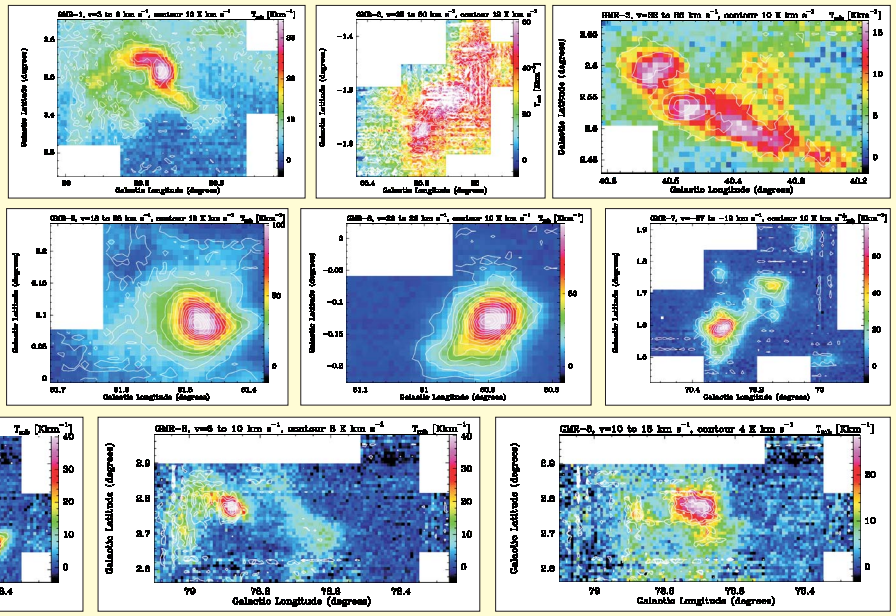
Introduction

We are conducting a multi-line study of isolated high mass star forming regions to thoroughly investigate the physical and chemical properties of these regions. In the poster we present the first results from ^{12}CO and ^{13}CO 2-1 and 3-2 observations of 7 clouds from our initial sample. We compare them with far and near-infrared as well as optical observations. In the future we aim to extend the study, e.g., to high density tracers such as CS, PDR region tracers such as CI, as well as high temperature tracers such as the CO 13-12 line observable with the 1.4 THz receiver presented in another poster (Wiedner et al.).
We used the MSX point source catalogue and 8.3 and 21.3 μm flux ratios typical of the selected UCHII regions. In addition the regions should appear isolated and lie between Galactic longitudes of 30 and 80°, which are observable from Zermatt (KOSMA) as well as Chile (1.4 THz Rx).

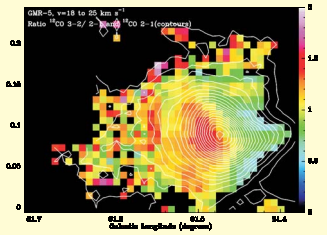
Observations

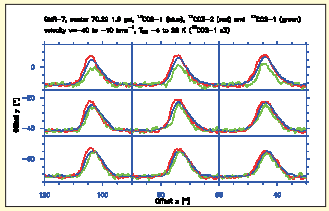
The inital observations of the high mass star forming regions were taken in March 2003 at the KOSMA telescope near Zermatt. All 7 objects were detected and mapped in ^{12}CO 2-1 and 3-2 (typical peak T_{MB}=20- 50 K) as well as in ^{13}CO 2-1 and 3-2 (typical peak T_{MB}=10- 25 K). Maps of at least 5' x 5' were taken, but often extended to cover the molecular cloud core(s) containing the infrared sources.
As an overview of the collected data, we present the ^{12}CO 2-1 emission in colour overlaid with ^{12}CO 3-2 in contours.



Line ratios

^{12}CO 3-2/2-1 ratios typically vary between 0.5 and 2. In all but one cloud, line ratios in excess of unity are found towards positions close to or on the infrared peak. This suggests temperature/ excitation gradients due to, e.g., external heating.

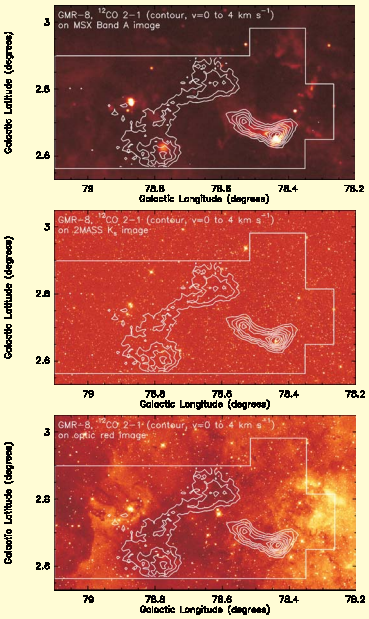




Spectral shapes

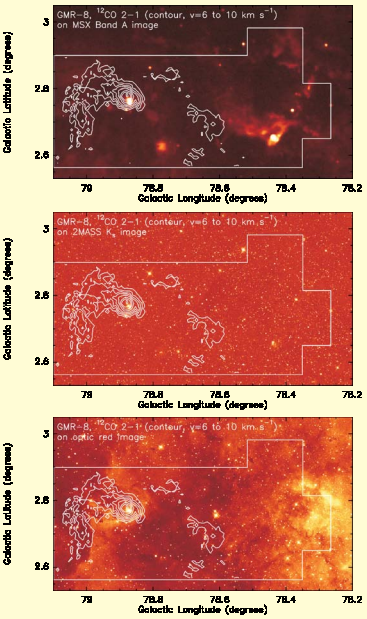
In four clouds we see clear indications of molecular outflows in most CO transitions. They are usually located close to the infrared source. As the outflows are also seen in ^{13}CO, large columns of molecular gas must be involved.

Comparison with infrared maps



In the example shown the stellar object or cluster is deeply embedded in the dense core of the cloud: The infrared source is still visible at 8.28 μm (top figure) but hardly at 2.17 μm (middle figure) and not at all in the optical (bottom figure). In contrast the optical image shows a dark cloud. This is an indicator of a young stellar object (YSO) or cluster in an earlier phase of star formation.

Towards the left of the same region, but at a different CO velocity, emission close to the CO peak is seen in all images at 8.28 μm (top), 2.17 μm (middle) and in the optical (bottom). This indicates that the YSO or cluster is in a later evolutionary phase of star formation. The emission peaks are slightly offset and a reflection nebulosity is seen in the optical. The CO emission beautifully coincides with the dark cloud seen in the optical.



Summary and outlook

We have selected a sample of 7 high mass star forming regions and mapped them in isotopomeric low-J CO transitions. These data combined with wide-field infrared (2MASS, MSX) and optical surveys suggest that the clouds contain star formation at different evolutionary stages. This is an excellent base for further observations such as mid-J and high-J CO transitions (KOSMA, 1.4THy Receiver) and both CI lines. These data in combination with models (radiative transfer, chemical) will allow us to study the physical and chemical properties, the impact of the UV field, and to gain more insight into high-mass star formation processes.