Conditions and Impact of Star Formation
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EXCITATION CONDITIONS AND ENERGETICS OF THE DENSE GAS IN M17 SW

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Abstract. The chemical and energetic conditions created by radiative feedback are probed with observations of multiple molecular transitions toward M17 SW. Extensive maps, including the ^{12}CO $J = 16 \rightarrow 15$, $J = 12 \rightarrow 11$, and $J = 11 \rightarrow 10$ lines, as well as the HCN $J = 8 \rightarrow 7$ and HCO^+ $J = 9 \rightarrow 8$ transitions, were obtained with the dual band receiver GREAT on board the SOFIA airborne telescope, and with the ground based APEX and IRAM 30 m telescopes. These data provide extensive line spectral energy distributions (LSEDs) of the CO, HCN and HCO^+ molecules (and their isotopologues). The excitation conditions of the three species are estimated simultaneously using the same density and temperature in a two-phase non-LTE radiative transfer model of the LSEDs.

1 Introduction

Stars are formed in dense molecular clouds which experience radiative feedback from UV photons, X-ray from stars, embedded pre-stellar cores, YSOs, and ultra compact H II regions. Observations of multiple molecular transitions are needed to probe the thermodynamics driven by such radiative feedback. A two-phase non-LTE radiative transfer model (with a cold and a warm component) of the LSEDs is used to estimate and constrain the excitation conditions and energetics at selected positions.

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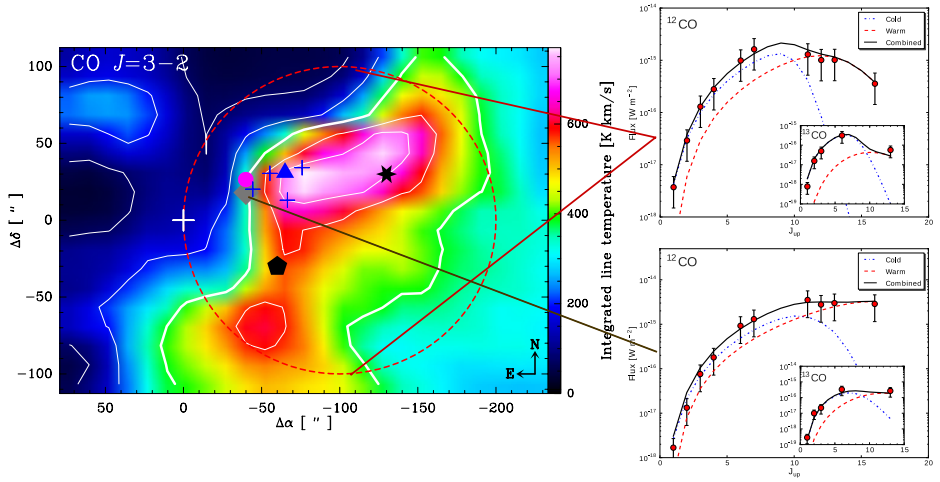

Fig. 1. *Left*: intensity map of ^{12}CO $J = 3 - 2$ showing the ultracompact H II region M17-UC1 and the four H_2O masers (Johnson *et al.* 1998) marked by the filled circle and plus symbols, respectively. *Right*: two component fit of the ^{12}CO LSED of the average spectra (*top*) obtained in the spatial scale of ∼2 pc covered by the dashed circle of 200″ diameter, and the LSED of the peak ^{12}CO $J = 16 - 15$ emission (*bottom*) at offset position (−40″, +18″). The fit of the ^{13}CO lines is shown in the inset. The cold and warm components are shown in dotted and dashed lines, respectively.

2 Results

Temperatures of up to 240 K are found toward the position of the peak emission of the ^{12}CO $J = 16 \rightarrow 15$ line, marked with a diamond in the left panel of Figure 1. High densities of 10^6 cm^{-3} were found at the position of the peak HCN $J = 8 \rightarrow 7$ emission, marked with a triangle in Figure 1. The LSED shape, particularly the high-J tail of the CO lines observed with SOFIA/GREAT, is distinctive for the underlying excitation conditions, as shown in the right panel of Figure 1. The energy balance at these positions is also studied by Pérez-Beaupuits *et al.* (2015), including the measured magnetic fields. Turbulent pressure dominates over thermal pressure in both cold and warm components at all selected positions. The total internal pressure of the cold components is larger than the external radiation pressure. The magnetic effects dominate thermal effects at most of the selected positions. Supersonic but sub-Alfvénic velocities in the cold component at most selected positions indicates that internal motions are likely MHD waves.

References

Johnson, C.O., Depree, C.G., & Goss, W.M., 1998, ApJ, 500, 302

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