Abstract

Context: Massive stars provide a major fraction of the energy in the interstellar radiation field. Their role in the cosmic matter circuit is important because they feed back energy into the natal cloud through stellar winds and UV radiation leading to the formation of new stars. Unfortunately, massive stars are short-lived and their formation cannot be observed easily. Most of the radiation from these stars is blocked by the surrounding dense cloud. Only continuum and line emission in the FIR & Submm can escape those regions unobscured and hence provide an unique diagnostic tool that allows an accurate determination of the physical and chemical conditions of the interstellar medium.

Aims: The physical properties of the three galactic high-mass star-formation sources W3, DR 21 and ON 1 are studied in detail. All of them show typical signs of massive star formation, such as a high bolometric luminosity, strong FIR line emission and a H II-Region. The molecular gas in these regions develop a warm and dense gas component that dominates the observed line emission and thus the energy balance of the gas. It resides beside a massive colder component of large H_2 column densities that corresponds to the cold dust. The relation between these two components is studied.

Methods: The approach presented here uses multi-component models of the molecular gas by calculating the full radiative transfer to deduce the temperature, density, species abundances and the velocity field. Only if these properties are known well enough, chemical models may be used to study the energy input coming from the stellar radiation field of the nearby massive stars.

Results: CO was found to be the second most important line coolant after O I, the most abundant element after H and He. C II and C I also provide major cooling lines covering different depths of a molecular cloud where radiation from an exciting star is sub-sequentially absorbed. High-*J* CO lines are especially useful to determine the densities, temperatures and mass fraction of the uv-processed gas. The found presence of these lines indicate a clumpy composition of the gas.

Conclusions: Radiative transfer models are a reasonable way to deduce physical properties of a molecular cloud if different excitation conditions are covered by the modeled lines. The state-of-the-art PDR models fail to explain the full set of observed line intensities from the different parts of a cloud showing massive star-formation, even if assuming a clumpy medium of uniform clumps. However, if the line selection is limited to only CO and ^{13}CO lines, a better agreement between model and observation can be reached. Future observational studies will have to better understand the energy balance of the gas, e.g. if other cooling channels of the gas besides the main cooling lines [O I], CO, [C II], and [C I] are significant.