Study of deuterated molecules in the PDR around the UCHII region Mon R2

Photo-dominated regions (PDRs) are ubiquitous environments where chemistry and heating are driven by UV photons from nearby O & B stars. The massive star forming region Mon R2 is the closest (830 pc) ultracompact (UC) HII region associated with a PDR. We are carrying out a spectral line survey of the PDR associated with Mon R2 using both ground and space based facilities, with the aim of investigating the chemistry of the molecular gas around the UCHII region and the possible variations due to the different local physical conditions. The last year we performed an unbiased spectral survey at 1, 2 and 3 mm, and discovered an unexpectedly rich chemistry. More than thirty different species (including isotopologues and deuterated compounds) were detected. Here we present the results of deuterated molecules, we derive the deuterium in the region and compare it with hot cores, dark clouds, and other PDRs.

The Mon R2 star forming complex

Mon R2 is a massive star forming region in the Monoceros molecular cloud (see Figure 1), located at a distance of about 830 pc. It contains the closest UCHII region (ionized by a B0 star; Downes et al. 1975, Wood & Churchwell 1989) which is associated with a PDR. Its angular size (~22', corresponding to 0.1 pc) makes Mon R2 the only UCHII region (plus PDR) that can be resolved by single-dish millimeter telescopes, thus being an ideal target for the study of the chemical and physical properties of the PDRs.

Mon R2 comprises several PDRs that can be spatially resolved in both the mm and IR domains. In addition to the PDR associated with the UCHII region, there is a low-UV PDR located to the north of it, which is probably the consequence of an external illumination of the molecular cloud (Pilleri et al. 2013).

Observations

The IRAM 30m telescope (Granada, Spain) was used to carry out a large spectral survey at 1, 2 and 3 mm toward Mon R2. On January 2012, we performed 2x2' maps of the region, obtaining an unbiased 64 GHz spectral survey at 1 mm (202.3-265.2 GHz), with a spectral resolution of 0.25 km/s, and an angular resolution of 10'. On July 2012, single-pointed spectral surveys at 2 and 3 mm were done toward two interesting positions: IF (0',0') and MP2 (0',40'). All the observations were carried out using the FT5200 backend.

Results, analysis and comparison with chemical models

Two velocity components. The component at 10-12 km/s is associated with the main PDR (0',0'). The one at 8.5 km/s is associated with the second low-UV PDR (0',40').

The [HCN]/[HNC] ratio is high, in agreement with model predictions for a dense and warm UV-irradiated region.

Deuterium is high in both PDRs, with some differences for species like CH and HCO+. Deuterium in the IF PDR is lower than deuteration in the northern low-UV PDR.

Summary of the main results

We have performed an unbiased spectral survey at 3 mm, 2 mm, and 1 mm, towards the PDR associated with Mon R2. More than 30 molecular species detected in the PDR. The spatial distribution shows a PDR with a cometary shape around the central UCHII region. A second low-UV PDR is found to the north of the main PDR. The high [HCN]/[HNC] ratio is in agreement with model predictions for a dense and warm UV-irradiated region. The low [HDCO]/[HCO+] and [DCO+]/[HCO+] ratios indicate that deuteration in Mon R2 is different to that found in dark clouds (cold objects) and hot corinos (hot objects). The chemistry in Mon R2 is similar to the chemistry of the PDR Orion Bar. A first comparison of observations and models suggests that the chemistry in Mon R2 (warm object) is controlled by gas-phase reactions via CH3D+ and C3DH+.