N_2D^+ abundance in high mass star forming regions

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We report the first detections of N_2D^+ in high mass star forming regions. This is of particular interest, since N_2D^+ is one of the best tracers for H_2D^+, a key molecule in the chemical network.

The early stages of star formation occur in dense ($\approx 10^6\ \mathrm{cm^{-3}}$), cold ($\approx 10\ \mathrm{K}$) and highly shielded ($\mathrm{A_v} \approx 100\ \mathrm{mag}$) cloud cores. In such environments, the chemistry is very different form other locations in the universe, because many endothermic and most neutral-neutral reactions are suppressed and most molecules freeze out onto dust grains.

Therefore H_3^+ and its isotopic variants are the most abundant ions and have a major impact on the whole chemical network. Hence these ions have a wide influence on the chemistry in their environment. The H_2D^+/H_3^+ ratio in particular affects the relative abundance of deuterated species of most molecules (e.g. Millar et al. 2000). The fractionation of deuterated molecules occurs because of the endothermicity of reactions like

$$\mathrm{H_3^+ + HD \rightarrow H_2D^+ + H_2} \ \ (\Delta \mathrm{E} = 220\ \mathrm{K})$$

For investigations of deuterium chemistry one would ideally observe the H_2D^+/H_3^+ ratio directly. However H_3^+ does not have a permanent dipol moment and the transitions of H_2D^+ are difficult to observe due to the low atmospheric transparency at its line frequencies. Because N_2 stays in gasphase quite long (compared to e.g. CO) its daughter molecule N_2D^+ is the next best tracer of cold gas and a probe for H_2D^+.

We observed several sources in high mass star forming regions in N_2D^+ J=3-2 (231 GHz) with the KOSMA 3m Telescope. Because of the large beam size (2'), the emission lines are very faint. Nevertheless, we have been able to detect N_2D^+ for the first time towards high mass star forming regions, namely S106 and the molecular ridge to the north of DR21 in Cygnus X.

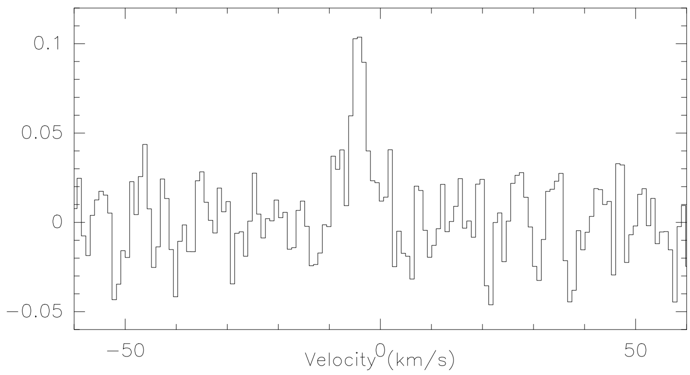

Figure 1: Spectrum of the molecular ridge in the north of DR21 obtained with the KOSMA 3 m Telescope. The Intensity is given in K ($\mathrm{T_{mb}}$).

The detections towards high mass star forming regions are of particular interest, because accelerated collapse, as it is suggested by Lintott et al. (2005) can be ruled out in sources where N_2D^+ had enough time to form. Towards the source near DR21, we also observed N_2H^+ (3-2). Assuming an excitation temperature of 10 K, we derived an N_2D^+/N_2H^+ ratio of 0.13, leading to an H_2D^+/H_3^+ ratio of 0.297 following the calculation of Crapsi et al. (2004). Because of the large beam size and the uncertainty of $\mathrm{T_{ex}}$, this ratio has to be treated with caution. Further observations with larger telescopes are intended to achieve an accurate N_2D^+/N_2H^+ ratio. Direct H_2D^+ measurements are planned with the CONDOR receiver (Bielau et al. this meeting).

References

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