DENSE CLOUD CORES

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In order to search for ultra-dense gas condensations as possible sites of future star formation, observations with highest possible angular resolution in high-gas density probing molecular species are required. Here we report first results from two-telescope (IRAM 30-m & CSO 10.4-m) multi-transition excitation studies of the linear molecules CS and HCN, both with critical densities $n_c \sim 10^7$ cm^{-3}. We obtained maps towards a number of galactic cloud cores in the CS(J=5-4;7-6) and the HCN(3-2;4-3) mm/submm transitions and those of their optically thin isotopic species ($C^{34}S$; $H^{13}CN$) accessible from ground. For a proper excitation analysis, the gas temperature has been determined independently from the symmetric top molecules NH_3 or CH_3CN. Here we present first results obtained towards the NGC 2024 molecular cloud core (Schulz et al. 1990).

The Dense Condensations in NGC 2024

Several recent mm/submm studies focused on the dense gas ridge buried within the optically prominent NGC 2024 dust lane. From their submm continuum observations Mezger et al. (1988) identified 6 small-scale dust clumps to which, in view of the very low dust temperatures (~16 K) and extremely high gas densities ($\geq 10^8$ cm^{-3}) deduced, they refer to as *genuine protostellar condensations*. As these clumps had not been recognized in earlier lower-resolution molecular line observations, the authors suggested strong molecular depletion onto dust grains.

Our detailed NH_3 and CS excitation studies revealed the density and temperature structure across the dense ridge which appears separated into two subregions by the disrupting effect of the southern HII-region. The global temperature structure derived closely corresponds with profiles of the dust color temperature given by Thronson et al. (1984), and is strongly suggestive of a heating scenario with the bulk sources of energy located outside the dense bar. The cloud material must be highly clumpy to allow the deep penetration depth of energetic photons.

Our 8.5-11" resolution CS maps show a general correspondence with the 1.3mm dust continuum emission. Embedded within the dense bar we find a number of small-scale clumps (size : 2-4 10^{-2} pc) which partly could be identified with submm dust knots. But basic dicrepancies are faced when physical characteristics are compared. Densities and column densities inferred from our LVG analysis of the CS excitation are high (~1-5 10^6 cm^{-3}; ~6 10^{23} cm^{-2}) but fall short of estimates from

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the dust emission by an order of magnitude. The overall gas mass of the dense bar amounts to 100-150 $M_\odot$, much lower than previous determinations. In the molecular line data, there is no evidence for the cold massive clumps deduced by Mezger et al., and the high CS brightness temperatures observed towards the clumps (~35-40 K) closely match the larger-scale NH_3 temperatures.

We re-analysed the NGC 2024 integrated dust spectrum and infer that the ambiguity of the decomposition procedure in particular allows a physically consistent fit that matches both the dust and the molecular line data without invoking a massive low-temperature component. These findings and recent reports of stellar activity associated with several of the dense clumps thus question their interpretation as cool protostellar condensations.

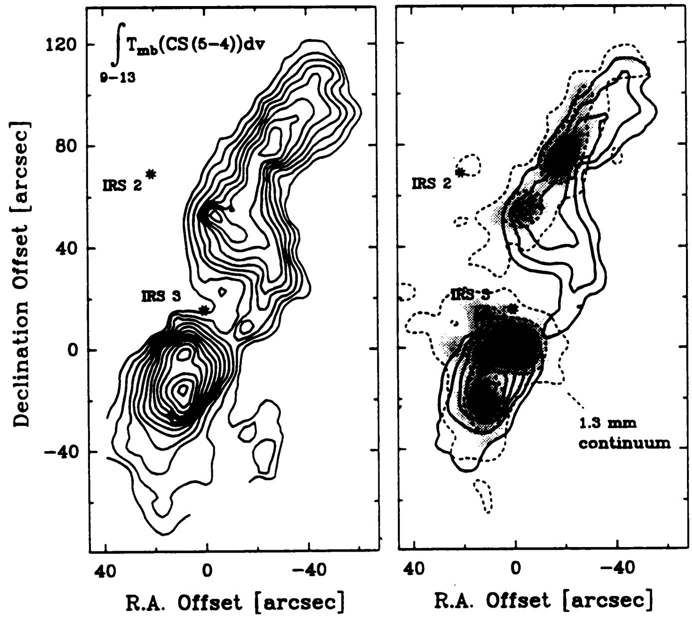

Fig. 1. Velocity-integrated CS(5-4) brightness temperature distribution superimposed on a grey-scale representation of the 1.3 mm dust continuum (Mezger et al. 1988), both taken with 11" angular resolution (IRAM 30-m). Positions of associated IR sources are marked by asterisks, the cross denotes the embedded H_2O maser.

References

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