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HIGH S/N HCO^+ MAPS OF THE ORION B DENSE CORE

PETER J. BARNES
Harvard-Smithsonian Center for Astrophysics, MS 42, 60 Garden Street, Cambridge, MA 02138, U.S.A.

RICHARD M. CRUTCHER
Astronomy Department, University of Illinois, 1002 West Green Street, Urbana, IL 61801, U.S.A.

ABSTRACT By combining new NRAO 12m data with previously published BIMA data, we have obtained very high signal-to-noise maps of HCO^+ in the Orion B core, which contain information on both the large- and small-scale emission and put new constraints on the gas' physical conditions.

Continuing our detailed studies of Orion B, a nearby site of massive star formation with many fascinating characteristics (Barnes *et al.* 1989; Barnes & Crutcher 1990, 1992), four BIMA lines (HCO^+ J=1→0, SO $J_K=2_2 \rightarrow 1_1$, $H^{13}CN$ J=1→0, and $HC^{15}N$ J=1→0) were mapped with the NRAO 12m. Figure 1 shows HCO^+ line maps from the combined data. Small-scale features described in our previous BIMA-only work (Barnes & Crutcher 1990) are still reproduced in this data cube. In addition, the inclusion of large-scale information from the 12m data reveals that the HCO^+ emission (especially at lower velocities) is very extended. At the lower velocities this emission corresponds to the foreground dust lane visible optically. This emission, typically ~5 K, suggests that the HCO^+ in the dust lane is either optically thin, very cold, or subthermally excited. One can see more low-level extended emission in other channels over most of the BIMA primary beam. Elsewhere, the peak line brightness is now ~30 K (up from ~20 K in the BIMA-only maps); thus the peak S/N of these maps is ~30, higher than any other BIMA spectral line dataset. Comparing such maps to the results of LVG radiative transfer models, one may deduce a minimum $T_{kin} \sim 35$ K for the peak emission, in good agreement with Schulz *et al.*'s (1991) calculations from CS observations. Coupled with Schulz *et al.*'s derived densities of ~$2–4 \times 10^6$ cm^{-3} for the far-infrared peaks FIR 4–6, we see that most of the HCO^+ emission is optically thick. However, the emission right <u>at</u> the peaks of FIR 4–6 corresponds only to $T_b \sim$ 15–20 K, implying $T_k \gtrsim$ 20–25 K. These temperatures are lower than Schulz *et al.*'s values but slightly above those derived by Mezger *et al.* (1988, 1992) on the basis of dust emission. Observations of higher-J transitions of HCO^+ are needed to decide if the gas temperatures <u>in</u> the FIR sources are closer to the cooler Mezger *et al.* numbers or are warmer as measured by other lines.

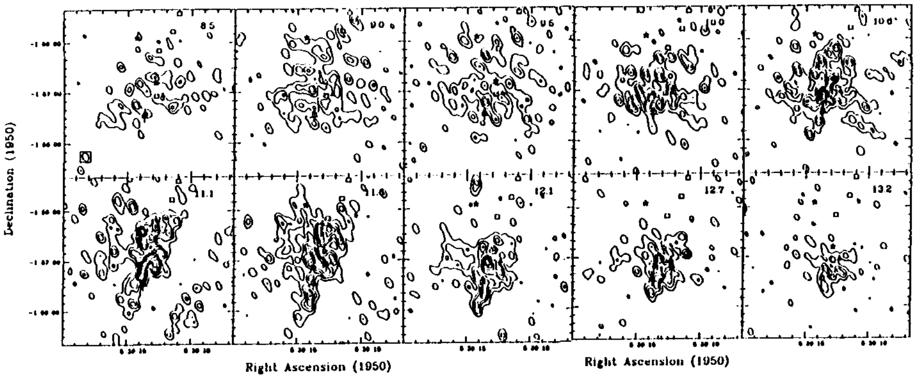

Fig. 1. Sample combined BIMA/NRAO 12m HCO^+ line maps, each labelled by the V_{LSR} in the top right corner. Contour levels are every 1.2 Jy bm^{-1} = 2.6 K = 2.7σ. The stars are near-IR sources, while the squares are the Mezger *et al.* FIR sources.

We have also obtained combined maps for the SO, $H^{13}CN$, and $HC^{15}N$ lines. The SO results, including the large-scale information and the peculiar sulphur chemistry, have been reported by Barnes & Crutcher (1992). Derived column densities and fractional abundances for SO are between those for massive star formation and those for dark clouds. However, the limited distribution of SO compared with Schulz *et al.*'s CS, coupled with the velocity offset between the two molecules, is not explained by any current model of sulphur chemistry (Leen & Graff 1988; Charnley, preprint). We can only say that SO seems to be a tracer of non-equilibrium chemistry. For $H^{13}CN$, where all 3 hyperfine components are detected, the hyperfine ratios indicate that the lines are *not* formed in LTE, nor can maps of HCN itself, assuming reasonable $^{12}C/^{13}C$ ratios, be optically thin as has been assumed (Thronson *et al.* 1984). Position-velocity cuts show that the isotopic HCN features have the same velocity as the HCO^+ in general. The $HC^{15}N$ emission is very faint.

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