

STRUCTURE OF THE DENSE MOLECULAR GAS IN THE HELIX NEBULA: LARGE SCALE MAPPING OF HCO⁺

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The Helix Nebula, NGC 7293, has been mapped in HCO⁺ J = 1 → 0 emission with a 70'' spatial resolution (1.68 km s⁻¹ velocity resolution) using the Arizona Radio Observatory (ARO) 12 m telescope on Kitt Peak. Over 200 individual positions covering an area of roughly 1000 × 800 '' were observed down to a 3σ noise level of ~20 mK. HCO⁺ was detected at over three-quarters of the positions, with the majority of spectra showing multiple velocity components indicative of a complex kinematic structure. The column density of HCO⁺ across the Helix ranges from N_{tot} ~ 1.4 × 10¹¹ to 2.4 × 10¹² cm⁻², with an average N_{tot} ~ 4 × 10¹¹ cm⁻². The HCO⁺ distribution, which traces gas with densities ~10⁵ cm⁻³, is similar to that of CO and H₂, with certain point symmetries and red and blueshifted regions common in all three molecules; these data are also consistent with observations of atomic lines. The HCO⁺ emission appears to trace two ring-like structures emanating from the central star: one is blue-shifted and the other red-shifted with respect to the star, and possibly trace the edges of a bipolar outflow.