USING HCO^+ LINE (& ITS ISOMERS) AS AN ASTROCHEMICAL TOOL TO PROBE THE STRUCTURE OF CLASS 0/I PROTOSTARS

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The chemistry of Class 0/I protostars have become increasingly important due to the mounting evidence of their impact on the chemical composition of future nascent planetary systems. Prior observations of molecular outflows, which are an energetic mass-ejection phenomenon associated with early stages of stellar evolution, have revealed that not only do these harsh environments contain a surprising array of complex molecules, but they also show highly-localized spatio-chemical differentiation. Because the velocities of these jets are relatively well-constrained based on mm-wave observations, it is possible to associate distance within the outflow with temporal evolution of chemistry. As well, the collimated nature of the outflows provides a relatively compact region in which comparisons can be made between outflow, shocked walls, and background ambient gas in a variety of density and temperature conditions as the chemistry evolves. We use Atacama Large Millimeter Array (ALMA) spectral line observations in the range of 300-360 GHz of HCO^+ line and its isomers in five outflows in the southern hemisphere of widely-varying ages, velocities, and chemical conditions to elucidate the underlying links between physical conditions, outflow properties, and chemical evolution in these important pre-stellar environments.