CONSTRAINING THE FORMATION OF FUNDAMENTAL INTERSTELLAR MOLECULES USING ISOTOPOLOGUES

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The formation of so-called complex molecules in the early stages of star formation has implications not only for how we decipher the evolution of planetary systems but also how we understand the evolution of molecules themselves. Interstellar complex molecules, which are simple by terrestrial standards, with only six or more atoms, are key precursors to the rich chemical diversity found in comets and meteorites and on planetary bodies. Isotopologues have proven useful in other areas of chemistry, for instance in pinning down formation mechanisms of molecules in synthetic organic chemistry, but there has been relatively little work done using isotopologues to understand how interstellar molecules form. Isotopologues have been used, however, in constraining the formation of molecules such as methyl cyanide (CH_3CN) and methanol (CH_3OH) in the Orion Kleinmann-Low nebula (Orion KL). Previous low-spatial-resolution studies of methanol in Orion KL have been inconclusive, and thus we have obtained high-resolution imaging data of deuterated methanol (CH_2DOH, CH_3OD) toward Orion KL with the Atacama Large Millimeter/submillimeter Array (ALMA). These data show the distribution of deuterated methanol on spatial scales commensurate with local star formation. Comparing the ratios of CH_2DOH and CH_3OD with $^{13}CH_3OH$, we aim to assess how methanol chemistry varies across the nebula and determine observationally whether the molecule is formed predominantly on the surfaces of icy dust grains as predicted by laboratory experiments and computational models. These results will be discussed as will the use of isotopologues in the laboratory. Constraining the formation of complex organic molecules in star-forming regions is a first step in understanding how even more complex chemistry—perhaps even prebiotic chemistry—evolved over the history of the universe.