P113a A Complete View of Complex Chemistry in Gas and Ice using ALMA and JWST

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The discovery of complex organic molecules (COMs) in solar-type protostars highlights the extensive chemical evolution at the onset of planet formation. These molecules, which are potential precursors to pre-biotic molecules, are also found in comets representing the solar system in its early stage. In recent years, the increasing detection of COMs by ALMA suggests a common presence of COMs in the protostellar phase. However, the formation pathways of COMs and whether most protostars undergo similar chemical evolution remain open questions with incomplete observational constraints. It is thought that COMs form in the ice mantles on dust grains followed by thermal sublimation near protostars, but direct observational constraints are scarce. While ALMA provides sub-100 au resolution, a resolution necessary to resolve sites of planet formation, to characterize gaseous COMs in nearby embedded protostars, measurements of chemical composition in ices had been limited by low-resolution and limited sensitivity spectroscopy until JWST. Thus, it is imperative to probe both gas and ice chemistry related to COMs, which can only be achieved with both ALMA and JWST. In this presentation, I will present the results of gas+ice chemical analysis in a Class 0 protostar, IRAS 15398−3359, using multi-configurations ALMA observations and the JWST CORINOS program, latter of which shows potential signatures of icy COMs. I will focus on methanol production from ice to gas and discuss the implications on the COMs (or the lack of) in gas and ice phase. I will also present an overview of the ice chemistry characterized by the JWST CORINOS program and the accompanied ALMA program to test the models of COM formation.