INTENSITY-CALIBRATED MOLECULAR SPECTROSCOPY AND ITS IMPACT ON METHANOL DEUTERATION STUDIES IN SPACE

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Methanol is the most abundant saturated-organic molecule and is known as an important species to form more complex organic molecules in interstellar clouds. However, deriving the actual abundances of methanol often suffers not only from the high opacity of the lines but also from the insufficiency of spectroscopic information. It is especially true for methanol isotopologues: the rotation transition of methanol significantly suffers from the uncertainty of intrinsic line intensities ($S\mu^2$) due to the floppy nature of this species. Although it is a critical parameter to derive accurate column density and temperature of the molecular gas, they are not straightforward to be evaluated theoretically, especially for the asymmetric-top asymmetric-frame isotopologue. By considering the importance of studying isotopic fractionation in methanol, we have developed an emission-type spectrometer, SUMIRE, using techniques developed for ALMA to determine line intensities and transition frequency of such species. Based on the laboratory measurement of line intensities, we first examined astronomical impacts on methanol deuteration. In this presentation, we will introduce application of our results on methanol deuteration study in the disk around an eruptive young star V883 Ori by utilizing ALMA Band 6 line survey. Deuterium fractionation, which refers to the enhancement of the D to H ratio in comparison to its elemental abundance, is a valuable tool for studying the physical and chemical characteristics of interstellar sources. Methanol is one of the molecules that exhibit significant deuterium enhancement, and its deuteration pathway has been extensively studied. It is postulated that mono-deuterated methanol, in particular, forms efficiently on grain surfaces prior to the onset of star formation. As a result, the D to H ratio is commonly used to probe history of the physical conditions in different astronomical sources. However, the ratio between CH_2DOH and CH_3OD often deviates from the expected value of 1 (or 3 if we consider the statistical weight) and even varies significantly depending on sources. Our study demonstrates the impact of precise spectroscopic data on determining the abundance of CH_2DOH, contributing to a better understanding of the methanol deuteration process. It would also help understanding the origin of high deuteration of water known in the solar system