Nuclear spin conservation and interstellar chemistry

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The total nuclear spin angular momentum of molecules that have identical nuclei with nonzero nuclear spin is known to be conserved in various physical and chemical processes. Even in chemical reactions in which atoms are scrambled and rearranged, the overall nuclear spin angular momentum of the reactants and products is anticipated to be conserved. Recently, by utilizing the unique features of quantum solid parahydrogen as a host for high-resolution matrix isolation infrared spectroscopy, we have shown that the total nuclear spin angular momentum is well conserved in the reaction between methylene (CH_2) and hydrogen (H_2) molecules to form a methane molecule (CH_4). It was found that the ratio of the ortho, meta and para methane is different between singlet methylene and the triplet methylene as a reactant due to the different reaction schemes between them. Since exchange between different spin isomers is, in general, a slow process,the ratio of spin isomers is useful information in order to clarify the origin of molecules how they were produced.

It has also been reported that the ratio of spin isomers of molecules such as *cyclic*-C_3H_2 in molecular clouds is different at different locations. Comparing with other observation data, there seems to be a correlation between the ratio of spin isomers and the chemical age of clouds. We will discuss the nuclear spin conservation in chemical reactions, and its relation to chemical evolution of molecular clouds.