Nuclear Spin Isomers of Water, Ammonia and Methane in Cometary Ices

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Comets are thought to be pimordial icy bodies in the solar system. Cometary ices keep the information of the chemical evolution of materials from the pre-solar molecular cloud to the solar nebula. We present abundance ratios of nuclear spin isomers of water, ammonia and methane in comets here. These abundance ratios are considered to be determined at the molecular formation or condensation on cold grains in the pre-solar molecular cloud or in the solar nebula. If the ratios were determined in thermal equilibrium, nuclear spin temperatures of different molecular species are consistent with each other. We will discuss on temperatures in the pre-solar molecular cloud where molceules formed on cold grains.