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Prediction of H, N and O isotopic compositions of outer planets

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Hydrogen, Nitrogen and Oxygen are major elements of the universe. Isotopic compositions of these elements are highly variable in nature. Due to highly volatile nature in the solar nebula, the chemical status is easily controlled as vapor and solid (ice) by environmental temperature and pressure. Thus, inner planets depleted in these elements, but outer planets contain as major elements. These characteristics among planets are roughly consistent to standard planetary formation model in the solar system. Isotopic variations among outer planets will be interpreted by a story according to the same planetary formation model. The model of the isotopic variation among planets would be an important key to clarify planetary formation. However, determinations of isotopic composition of each outer planet limit several planets and the values have large uncertainties. In this report, we propose new systematic approach to infer isotopic compositions of H, N and O of outer planets based on augmented model for oxygen isotopic evolution in proto-planetary disk by Yurimoto and Kuramoto (2004). The augmented model in this study includes two key points, i.e., 1) temporal preservation of chemical species fractionated in mass by some chemical reactions and 2) astronomical space separation by dynamic coupling between chemical status changes of the species and the dynamics. The model assuming appropriate parameters interpret H isotope variations between Jupiter/Saturn and Uranus/Neptune by planet explorations. We infer enrichments of 15N in the order of Jupiter, Saturn, and Uranus/Neptune. The 15N/14N ratio of Uranus/Neptune would be larger than the terrestrial value. Oxygen isotopic composition among outer planets would be mass independent and 16O component would be depleted in the order of Jupiter, Saturn and Uranus/Neptune. These predictions would be evaluated by future planet explanations for outer planets.

Keywords: outer planet, isotope, hydrogen, nitrogen, oxygen