Nuclear spin isomers of photodesorbed water from ice at 10 K

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Recent astronomical observations have observed H_2O in space. The ubiquity of H_2O makes it essential to clarify the chemistry of interstellar H_2O to further our understanding of the formation of stars and planetary systems, including our solar system. [1]

A key observable related to interstellar water chemistry is the abundance ratio of nuclear spin isomers (the ortho-to-para ratio, OPR), because it is a valuable tracer of the physical and chemical history of H_2O. Cometary comae, and star- and planet-forming regions have of OPRs for gaseous H_2O (0.1–2.4), which are anomalously lower than the statistical value of 3. The OPR of H_2O in a comet has been considered a indicator that gives the past formation temperature (30 K) of the ice nucleus in the solar nebula. The low OPR of interstellar H_2O has also been used to determine the formation temperature (<50 K) of water ice on cold interstellar dust. However, the use of the OPR as a temperature probe requires the assumption that the OPR of H_2O desorbed from ice is related to the ice temperature. However, the OPR of H_2O desorbed from ice remains poorly understood, especially at low temperatures, and the above assumption has not been validated. Therefore, the significance of the OPR of water is unknown and remains one of the most problematic issues in astronomy and planetary science. [2]

The present study performed direct measurements of the OPR of water photodesorbed from water ice at 10 K. The photodesorbed water showed the statistical high-temperature OPR of 3, even when the ice is produced in situ by hydrogenation of O_2, a known formation process of interstellar water. Our results indicate that the OPR did not reflect the formation temperature of the ice (10 K, OPR = 0.3). Reinterpretation of previous observations is necessary and will improve our understanding of interstellar chemistry, and the formation of the solar system and comets. [3]

References

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